DOCUMENT RESUME

ED 425 053 SE 060 438

TITLE	Environmental Education Compendium for Water Resources.
INSTITUTION	California State Dept. of Education, Sacramento.; California State Dept. of Water Resources, Sacramento.
PUB DATE	1996-11-00
NOTE	493p.
PUB TYPE	Collected Works - General (020) -- Guides - Non-Classroom (055) -- Book/Product Reviews (072)
EDRS PRICE	EDRS Price MF2 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Conservation Education; Elementary Secondary Education; *Environmental Education; Hands on Science; Hydrology; Instructional Material Evaluation; *Interdisciplinary Approach; Resource Materials; *Science Activities; Science Education; State Curriculum Guides; Water Pollution; *Water Quality; *Water Resources
IDENTIFIERS	California

ABSTRACT

Interdisciplinary by nature, environmental education is appropriate in any subject area and many educators often integrate environmental concepts into their lesson plans. This compendium of 109 collections of curriculum materials has been developed to assist educators in their selection of materials focusing on water resources. Curricula cover such topics as water science, watershed management and protection, water pollution, water resources and conservation, and related human/societal issues. At the primary level, a predominant number of curricula focus on the physical and chemical properties of water and the role of water in students' lives. The content offers a diverse selection of activities in science, geography, language arts, history, and social studies at the upper elementary level. Intermediate and secondary level curricula frequently address sustainable water use as well as political and economic systems that govern water use within the context of societal values and cultural beliefs. Descriptive and evaluative information on each curriculum is presented. Curricula were evaluated for appropriateness at four grade-group levels: K-3, 4-6, 7-9, and 10-12. The materials were evaluated to identify those curricula that align with California education frameworks and that are accurate and comprehensive in their presentation of issues related to the topic of water resources. Each curriculum described in the compendium received an overall grade of B- or above. Supplemental materials not deemed curricular in design are listed in the appendices along with other resources. (PVD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 425 053

Environmental Education

Compendium for Water Resources

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY HAS BEEN GRANTED BY

C. Robinson

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

A Cooperative Presentation by:
The California Department of Education
The California Department of Water Resources
November 1996

Environmental Education Compendium for Water Resources

A Cooperative Presentation by:

The California Department of Education
The California Department of Water Resources

November 1996

Copyright 1996 by the California Department of Education

Printed on recycled paper

To the Educator

Dear Educator,

It is our pleasure to present the second edition of the Compendium for Water Resources, a cooperative project by the California Department of Education and Department of Water Resources. This second edition is the result of an entirely new nationwide search for environmental education curricula published in the mid 1990's.

We recognize that educators face an enormous challenge in integrating environmental education into the classroom. While a great deal of material exists within the realm of environmental education, some may not be readily accessible or may fail to meet the high standards established by the California education frameworks.

Current educational theory promotes the ability of students to actively construct their own knowledge of environmental concepts and issues through research, discussion, exploration, and application. This understanding provides students with the tools to analyze diverse perspectives, apply their own knowledge, and develop strategies for responsible action.

In the context of water resources, it is hoped that students will become informed citizens who will make wise decisions that facilitate the best use of the state's limited water supplies. You, as an educator, play a vital role in this process by making a study of water resources a part of your classroom activities.

This compendium is one in a series providing information on quality environmental education instructional materials. We hope the Compendium for Water Resources provides you with resources to instruct and empower your students as they examine water from a variety of perspectives.

We offer this compendium to you and to the children of California.

Sincerely,

William H. Andrews
Bill Andrews, Consultant
Environmental Education Office
California Department of Education

Anita Garcia-Fante
Anita Garcia-Fante, Chief
Office of Water Education
Department of Water Resources

Acknowledgments

The following individuals made significant contributions in the writing and development of this document:

Jennifer Rigby, Water Resources Project Consultant
The Acorn Group

Gary Smith, Curriculum and Compendium Project Coordinator
Anaheim Union High School District

Bill Andrews, Education Programs Consultant
California Department of Education

Carolyn Tucker, Water Education Specialist
California Department of Water Resources

Layout and design:

California Department of Water Resources
The Acorn Group

Cover art:

California Department of Education, Bureau of Publications

The following individuals reviewed and evaluated the curriculum materials presented in this document:

Ann Allen, McCauliffe Intermediate School, Los Alamitos
Sandra Baerwald, John Muir School, Hayward
Deby Everton, Lincoln Elementary School, Ventura
Margaret Fauchier, Mary Bird High School, Fairfield
Richard Filson, Edison High School, Stockton
Laura Graham, Bergeson Elementary School, Laguna Niguel
John Jackson, Monterey Highlands School, Monterey Park
Jeff Jones, Columbus Elementary School, Glendale
Betsy Leonard, Environmental Education Consultant, San Diego
Cathy Love, Environmental Education Consultant, Sacramento
Randy Malandro, Morada Middle School, Stockton
A. C. McNeil, A. E. Kent Middle School, Kentfield
Peter Moras, Sherwood School, Salinas
Barbara Moreno, Open Charter School, Los Angeles
Muthena Naseri, Moorpark College, Moorpark
Dennis Pilien, Bravo Medical Magnet High School, Los Angeles
Diane Reynolds, St. Andrew's School, Saratoga
Michael Sixtus, Mar Vista High School, Imperial Beach
Karn Steigelmeir, Mt. Tamalpias School, Mill Valley
Bonnie Styles, National School District, National City
Louise Wathen, Fruitvale Elementary School, Hemet
Suzanne Weisker, Wilsey Wood High School, Vacaville
Betsy Weiss, Paden Elementary School, Alameda
Stephany Yescas, John Adams School, Stockton

The following individuals served as compendium advisors:

Lynn Anderson-Rodriquez, Santa Barbara County Water Authority
Bill Andrews, California Department of Education
Ivan Golakoff, San Diego County Water Authority
Marilynne Homitz, East Bay Municipal Utility District
Trude Hurd, National Audubon Society, San Joaquin Wildlife Sanctuary
Jennifer Rigby, The Acorn Group
Gary Smith, Anaheim Union High School District
Dave Todd, City of Fresno
Carolyn Tucker, California Department of Water Resources

Funding for this project was provided by:

California Department of Water Resources and State Water Contractors
California Department of Education
California Water Awareness Campaign
Metropolitan Water District of Southern California
Santa Clara Valley Water District
East Bay Municipal Utility District
State Water Resources Control Board
Walnut Valley Water District
Kern County Water Agency
Alameda County Water District
City of Tracy

All reprinted materials have been copied with the permission of the sponsoring organizations or publishers.

Table of Contents

About This Compendium i

Significant Findings iii

Field Guide to the Reviews 1

Materials for Grades K - 3

All About Water 2-3
Project WET Curriculum and Activity Guide 4-5
The Ways of the Watersheds 6-7
Aquatic Project WILD 8-9
The Comprehensive Water Education Book 10-11
A Sense of Water 12-13
Gee-Wow! Adventures in Water Education 14-15
Water Precious Water 16-17
Water Is Your Best Friend 18-19
WOW! The Wonders of Wetlands 20-21
FOSS Water Module 22-23
Always a River 24-25
The Streamside Community 26-27
The Green Box 28-29
Hands On Save Our Streams 30-31
What Is a Watershed? 32-33
Water Cycle, the Earth's Gift 34-35
Water, Stones, and Fossil Bones 36-37
Wet and Wild: The Physical Ocean 38-39

Materials for Grades 4 - 6

Project WET Curriculum and Activity Guide 40-41
A Child's Place in the Environment: Caring for Aquatic Systems 42-43
Aquatic Project WILD 44-45
The Ways of the Watersheds 46-47
The Water Sourcebook 48-49
WOW! The Wonders of Wetlands 50-51
The Comprehensive Water Education Book 52-53
Water Wisdom 54-55
Always a River 56-57
Understanding Our Environment 58-59
Hands On Save Our Streams 60-61
A Sense of Water 62-63
Gee-Wow! Adventures in Water Education 64-65
Fish in Schools 66-67
Water Precious Water 68-69
Vista Del Lago Teacher's Guide 70-71
Living in Water 72-73
From Ridges to Rivers: Watershed Explorations 74-75
California Water Story 76-77
The Official Captain Hydro Water Conservation Workbook 78-79
Active Watershed Education Curriculum Guide 80-81
Admiral Splash 82-83
Waterways 84-85
FOSS Water Module 86-87
Teaching Aquifer Protection Notebook 88-89
California Smith, Water Investigator 90-91
Groundwater: A Vital Resource 92-93
Water, Stones, and Fossil Bones 94-95
Learning To Be Water Wise and Energy Efficient 96-97
Water from Nature to You 98-99
Water Cycle, the Earth's Gift 100-101
Wet and Wild: The Physical Ocean 102-103
Where in the World Is the Water? 104-105
The Geography of Water 106-107

Materials for Grades 7 - 9

Project WET Curriculum and Activity Guide 108-109
WOW! The Wonders of Wetlands 110-111

The Ways of the Watersheds 112-113
San Diego: World in Harmony 114-115
Earth, the Water Planet 116-117
Hands On Save Our Streams 118-119
Always a River 120-121
Water Wisdom 122-123
The Stream Scene 124-125
Water Champs, Water Quality in the Champlain Drainage Basin .. 126-127
California CLASS Project 128-129
Environmental Science Activities Kit 130-131
Groundwater Study Guide 132-133
A Sense of Water 134-135
Ground Water Education 136-137
Acid Rain 138-139
Water Activities Manual 140-141
The Further Adventures of Captain Hydro1 142-143
Every Drop Counts 144-145
Understanding Our Environment 146-147
Groundwater: A Vital Resource 148-149
California's Water Problems 150-151
Down the Drain 152-153
Project Water Science 154-155
Project Earth Science: Physical Oceanography 156-157
Learning To Be Water Wise and Energy Efficient 158-159
Aquatic Ecosystems 160-161
River Cutters 162-163
H2O-2010 164-165
Water, Stones, and Fossil Bones 166-167
Hands-On Environmental Science Activities 168-169
Water Watchers 170-171
The Geography of Water 172-173

Materials for Grades 10 - 12

Project WET Curriculum and Activity Guide 174-175
San Diego: World in Harmony 176-177
Rivers Project 178-179
Issues, Evidence and You: Water Usage and Safety 180-181
WOW! The Wonders of Wetlands 182-183
Water Politics 184-185
Hands On Save Our Streams 186-187
A Sense of Water 188-189
Project Water Science 190-191
Water Wisdom 192-193
The Stream Scene 194-195
Ground Water Education 196-197
H2O-2010 198-199
Global Change for the Great Lakes Region 200-201
Environmental Science Activities Kit 202-203
Earth Matters 204-205
Groundwater: A Vital Resource 206-207
Teacher's Guide to World Resources 208-209
A Curriculum Activities Guide to Water Pollution 210-211
California's Water Problems 212-213
The Fluid Earth 214-215
Hands-On Environmental Science Activities 216-217
A Curriculum Activities Guide to Watershed Investigations 218-219

Appendices

Overview and Unifying Concepts 220-221
Conceptual Matrices 222-223
Water Resources Evaluation Tool 224-226
Supplemental Materials and Other Resources 227-238

About This Compendium

INTRODUCTION

This compendium is an easy-to-use guide to environmental education materials focusing on water resources. Interdisciplinary by nature, environmental education is appropriate in any subject area, and many educators often integrate environmental concepts into their lesson plans. Finding suitable materials, however, can be a time-consuming and complicated task. This compendium of curriculum materials has been developed to assist educators in their selection of materials appropriate for classroom use.

CONTENT OF CURRICULA

An extensive national search was conducted to locate teaching materials that pertain to water resources. Through this process, numerous areas of study within the topic area were identified, including water science (physical and chemical properties of water and hydrology); surface water, groundwater, and watershed management and protection; water pollution (including nonpoint-source pollution) and water quality monitoring; water resources and conservation; and related human/societal issues. A majority of the curricula focused on water resource issues within the context of the human community, namely the creation and consequences of water supply systems and water management policies.

Several curricula began with a study of water science, progressed through an examination of current water resource issues, and concluded with involvement in community action projects. These materials investigated sources of water pollution, causes of water shortages, and historic and contemporary water use conflicts. A number of the curricula were designed specifically for use in California and used regional water issues for case studies.

Where community action projects were identified, students were offered the opportunity to adopt areas of study, ranging in size from puddles to watersheds. In many cases, scientific investigations concluded with presentations before other classes or community groups. Such opportunities allow students to apply skills in real-life applications and to develop a sense of genuine empowerment, particularly when their efforts result in the restoration of an area.

> *"The lesson to be mastered must be explicable in terms of truth already known by the learner ... the unknown must be explained by means of the known."*
>
> JOHN MILTON GREGORY
>
> *Water is within the experience of all of us. It is a "truth already known".*

EVALUATIONS

On the following pages, both descriptive and evaluative information on each curriculum are presented. Evaluation scores are based on statistical means derived from the data. Two sample pages are featured from each curriculum. Due to the length of some lessons, only a portion of the sample lesson may be provided. Each evaluation includes a description of the curriculum, ordering information, a "report card," discipline emphasis, and brief comments from evaluators. Exact quotes from the reviewers are given quotation marks. Comments, generalized from the reviewers, are not given quotation marks.

REVIEWERS

The curricula were evaluated by two teams of educators from throughout California. These educators were chosen on the basis of their outstanding environmental education experience and expertise, as well as background in the topic area and state education frameworks. This distinguished group of evaluators has provided an important service to everyone associated with environmental education.

MATERIALS

The curriculum materials were evaluated with the use of an evaluation tool developed by the California Department of Education in collaboration with other state agencies. The goal of this evaluation was to identify those curricula which align with California education frameworks and are accurate and comprehensive in their presentation of issues related to the topic of water resources.

Curricula were evaluated for appropriateness at four grade-group levels: K - 3, 4 - 6, 7 - 9, and 10 - 12. Each piece was evaluated by a team of educators with teaching experience at the target grade-group level. Multi-level curricula were evaluated at each grade level that they encompassed, resulting in some curricula being evaluated at four grade-group levels.

Each curriculum described in this compendium received an overall grade of B- or above. These materials are highlighted in the main part of this document. Supplemental materials not deemed curricular in design are listed in the appendices, along with other resources.

For ease of use, the main body of the compendium has been divided into the four grade-group sections. Curricula are arranged within each section by rating: those with the highest ratings are listed first. Some curricula appear in more than one grade-group section.

APPENDICES

Included in the appendices are a description of the Curriculum and Compendium Project coordinated by the Office of Environmental Education within the California Department of Education; the Unifying Concepts for Environmental Education; the Conceptual Matrix for Water Resources; a correlation of the Conceptual Matrix to seven California education frameworks and the California Education Code; the evaluation tool; and listings of supplemental materials, water quality monitoring resources, software, and addresses for several organizations that provide on-line information about water resources.

FUNDING

This project was funded by the California Department of Water Resources and California Department of Education's Environmental Education Grant Program. Additional sponsors are noted in the acknowledgements section.

CONCLUSIONS

While this compendium was developed to reveal the strengths and weaknesses in existing curricula, it was also intended to serve as a guide for future curriculum development. The project identified several outstanding curricula in the field of water resources; however, even some of these materials could benefit from further refinement.

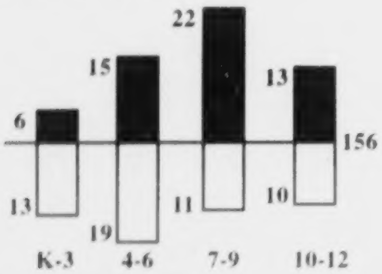
Three conclusions have been drawn from the review process: (1) in a manner similar to most of the other five compendia, the greatest number of curricula exists for the 4 - 6 and 7 - 9 grade-group levels, and the weakest curricula are found at the K - 3 grade-group level; (2) recently-published curricula provide more opportunity for student involvement in water quality and watershed monitoring programs than older curricula; and (3) due to the structure of the evaluation tool, curricula covering a wide range of environmental topics may not have scored as high on specific content as those focusing exclusively on water resources. This is not meant to imply that such curricula are inadequate, but only that they may not cover the subject of water resources thoroughly.

One additional comment pertains to spelling. During the review process, the terms "groundwater" and "ground water" were encountered. In accordance with the official California Department of Water Resources policy, it has been spelled as one word throughout this document, except where cited in a specific title where it may appear as two words.

Lastly, this compendium is intended as a tool for educators interested in integrating into their classrooms a study of water resources and all that it encompasses. Such an effort would promote an appreciation for water as a limited natural resource, an understanding of its properties and roles, and an ethic of stewardship for its conservation and protection.

Significant Findings

One purpose of this review was to identify strengths and to reveal areas needing improvement in existing material so that direction is provided for the development of future curricula in the topic area. After a preliminary screening, 109 pieces were submitted for formal evaluation, and all 109 scored high enough for inclusion in this compendium. Findings related to the curricula are summarized below.



Each evaluated curriculum earned an overall score based on the evaluation tool included on pages 224 - 226. The number of points possible was 250. This graph displays the number of materials, by grade level, scoring above or below the average score of 156.

DEVELOPMENT

Fifty-six per cent of the curricula was developed by private organizations and academic institutions; twenty-four per cent by water utilities; fourteen per cent by governmental agencies; and six per cent by county or state education offices. Several curricula were products of teacher training efforts and indicated field-testing prior to publication and release of the material.

CONTENT

At the primary (K - 3) level, a predominant number of curricula focused on the physical and chemical properties of water and the role of water in the students' lives. Observing the three states of water and experimenting with solutions, surface tension, and evaporation were among the concrete activities offered.

At the upper elementary level (4 - 6), the content area shifted, offering a diverse selection of activities in science, as well as geography, language arts, history, and social studies.

Intermediate and secondary level curricula frequently addressed the issue of sustainable water use: the ability to meet the needs of present generations without compromising those of future generations. Some materials examined the political and economic systems that govern water use within the context of societal values and cultural beliefs. A theme emphasized within most curricula is that water is a finite resource whose purity is essential to all life.

GRADE LEVEL COVERAGE

Eighteen per cent of the curricula examined were directed at grades K - 3; thirty-one per cent in grades 4 - 6; thirty per cent in grades 7 - 9; and twenty-one per cent in grades 10 - 12. The greatest percentage of high-scoring curricula (above the mean score of 155.65) was found at the 7 - 9 grade level, a finding not replicated in other compendia. The lowest percentage of high-scoring material was found at the K - 3 grade level, a finding similar to that in both the *Compendium for Integrated Waste Management* and *the Compendium for Natural Communities.*

PEDAGOGY

A majority of curricula conveyed creative, hands-on activities, although these were not necessarily accompanied by authentic assessment tools or cooperative learning strategies. At the lower grades, assessment was based primarily on completion of paper and pencil worksheets and fill-in-the-blank tests. At the upper grades, more opportunities were offered for students to apply skills in real-life situations.

MULTILINGUAL MATERIALS

Only a few curricula have been translated into Spanish. Some materials, primarily at the secondary level, offer multicultural perspectives on water resource issues, including global comparisons of water distribution, water withdrawals and shortages, and the availability of safe drinking water.

To more fully respond to the cultural diversity of California's students, more environmental education materials could be provided in the primary languages of participating students.

VISUAL PRESENTATION

The majority of the curricula reviewed offered easy-to-read formats and adequate graphic design. Several curricula were accompanied by visually striking, four-color maps and posters depicting California waterways.

Field Guide to the Reviews

Title

Publisher
Address
Phone Number / Contact Person

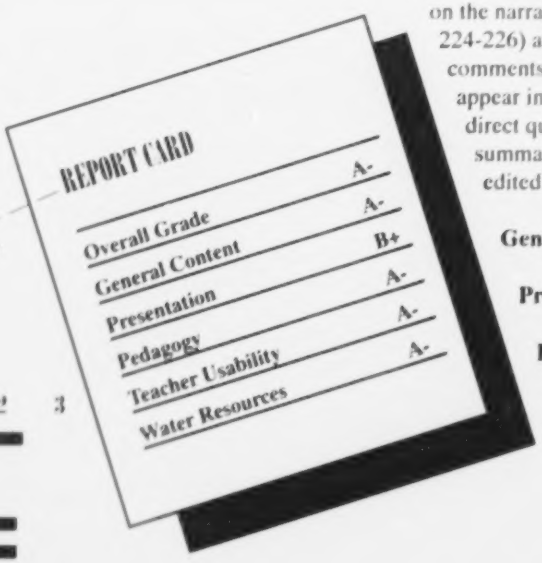
☁ ☁ ☁ ☁

Cost / Date / Pages

Each curriculum received an overall grade, as noted in the Report Card. This grade corresponds to the number of icons appearing here: 5 icons represent A+, 4 1/2 icons, A, 4 icons, A-, 3 1/2 icons, B+, 3 icons, B, and 2 1/2 icons, B-

Description

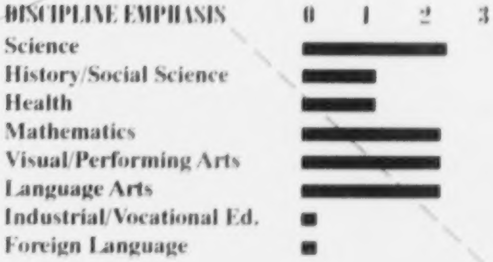
Descriptions are based on information from the curriculum's introduction. This description may mention units or modules not specified after the title; these units or modules may appear at other grade levels or may not relate to water resources.



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	A-
Water Resources	A-

These grades reflect the average numeric score assigned by the reviewers for each evaluation area. (See Evaluation Tool, pages 224-226)



Evaluators were asked to indicate the degree of emphasis placed on each discipline. Results are reflected on this scale. Zero (0) indicates no emphasis, one (1) indicates some emphasis, two (2) indicates more emphasis, and three (3) indicates major emphasis.

COMMENTS

These comments reflect the evaluators' written responses on the narrative portion of the evaluation tool (see pages 224-226) and are catergorized by topic. If there were no comments on a particular topic, that heading will not appear in the comments section. Comments that are direct quotes appear in quotation marks; others summarize the evaluators notes and have been edited for clarity.

General Content

Presentation

Pedagogy

Teacher Usability

Specific Content on Water Resources

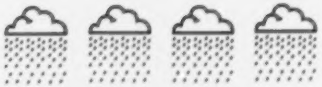
The facing page contains two sample pages from the curriculum. Many lessons are more than two pages in length. "Sample" pages, therefore, may not include an entire lesson.

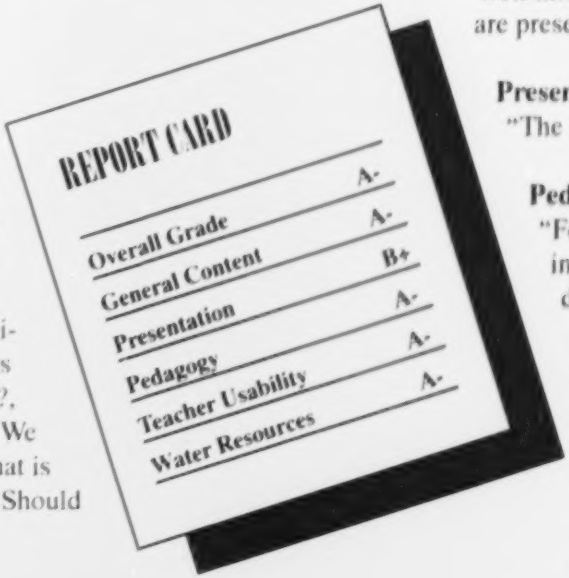
All About Water

Department of Water Resources
Publications Office, Room 338
P.O. Box 942836
Sacramento, CA 94236-0001
(916) 653-1097

No charge. 1991. 98 pages.

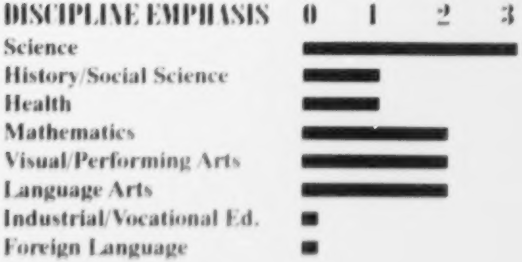
"All About Water" is designed to teach primary students about water within the context of being a limited and vital resource. A *droid* character and optional flannel board materials weave the activities together in a storyline sequence. Twenty-six activities are organized within five chapters entitled: How Does Water Get To Us?, How Much of the Earth's Water Can We Drink?, How Do We Use Water?, What is Happening To Our Water?, and How Should We Take Care of Our Water?





REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	A-
Water Resources	A-



COMMENTS

General Content
"Well integrated and 'teacher-friendly' lessons on water resources are presented in 'All About Water.'" "I would definitely use this!"

Presentation
"The format is nice, making it easy to use."

Pedagogy
"Follows California Science Framework themes and thinking processes." "A 'top-notch' curriculum." Activities are developmentally appropriate.

Teacher Usability
Well integrated and teacher-friendly; songs are a welcomed addition.

Specific Content on Water Resources
In addition to covering a variety of water resources topics, "All About Water" addresses agricultural growth and geographical issues related to water.

PIPES

QUESTION: How does water get to your classroom?

OBJECTIVE: Students will gain an understanding of the path that water takes to get to their classroom.

ACTIVITY: This is an introductory lesson that traces the path of water from natural sources to homes through a system of pipes. Students will make a model using straws as pipes.

EXPECTED OUTCOME: A model will be completed.

CURRICULUM CONNECTION:	**THINKING PROCESSES:**
Science	Observing
Geography	Communicating
Art	Ordering

BACKGROUND NOTES: Fresh water takes the path from natural sources such as lakes, rivers, streams and ground water to reservoirs or wells and on to water treatment plants. Once the water has been treated and quality checked, it is piped to homes and schools. There are two systems of pipes: the water pipes bringing in fresh water and the sewer pipes taking out the used waste water.

BEFORE YOU START:

1. Use flex straws to represent turns in the pipes.

2. If students are unable to cut straws, prepare straws ahead of time.

MATERIALS:

flex straws
regular straws
white glue
activity sheets
scissors
crayons
Q-tips
tape

PROCEDURES:

1. **Droid Link:** Take the question strip from H_2O..."Hold on to your memory banks, we've got quite a story ahead! How does water get to your classroom?"

2. Ask the question — record all responses on the board.

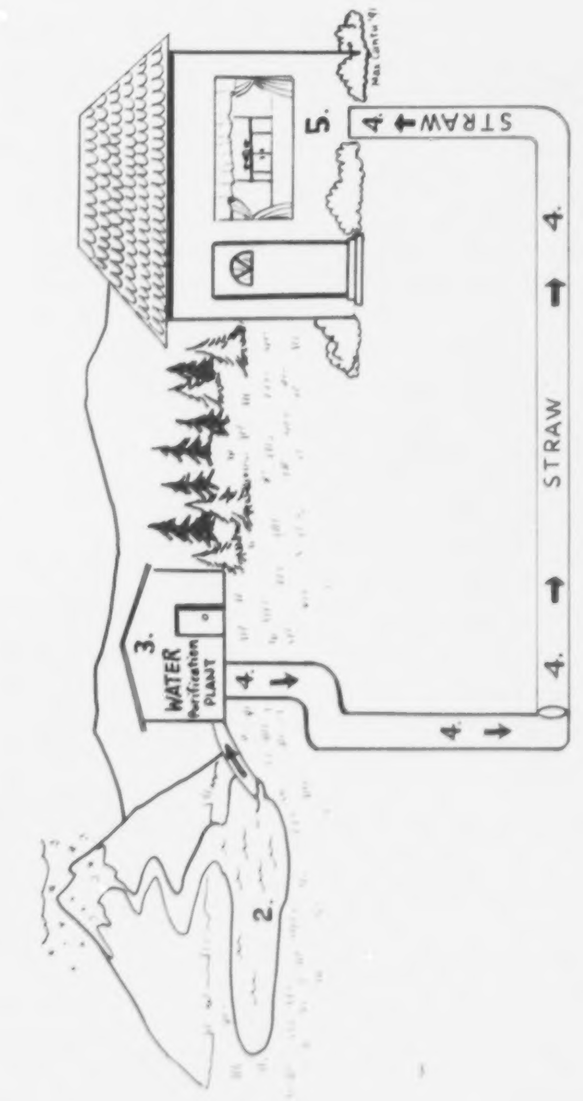
3. Summarize and discuss how water is transported through pipes to our classroom and homes. The discussion includes the overall picture of where water comes from including the water treatment plant, reservoirs, wells, lakes, streams, rivers, and ground water.

Younger Students — single activity sheet with star in the lower left corner

4. Teacher makes and demonstrates the sample activity sheet as follows:
   a. Using their finger they trace the path that water takes from #1, the cloud, through to #5, the home.
   b. Fold up the bottom ⅓ of the paper along the solid line.
   c. Color the outside of the folded edge to represent grass or the ground.
   d. Glue the flex straw in the pipe area labeled "straw."

Older Students — Two activity sheets with a water drop in the lower left corner.

4. Teacher makes and demonstrates the sample activity sheets as follows:
   a. Using your finger, trace the path that the water takes from the natural sources to the classroom and then to the ocean or lake by following these directions:
      1) Begin by putting your finger on the cloud and following the water to the reservoir/lake, and to the Water Purification Plant. With your other hand, trace the path from the speckled ground layer, up the straw, to the well and into the Water Purification Plant.
      2) From the treatment plant go through the pipes to the buildings.
      3) To follow the path of the waste water, trace the flow from the buildings to the treatment plant using the shaded pipes and then on to the ocean or lake.

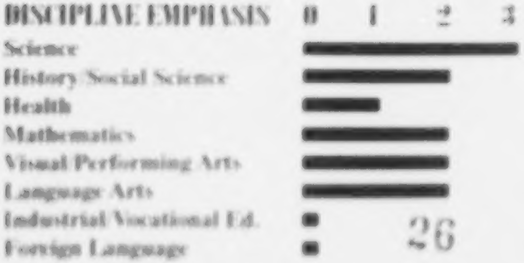


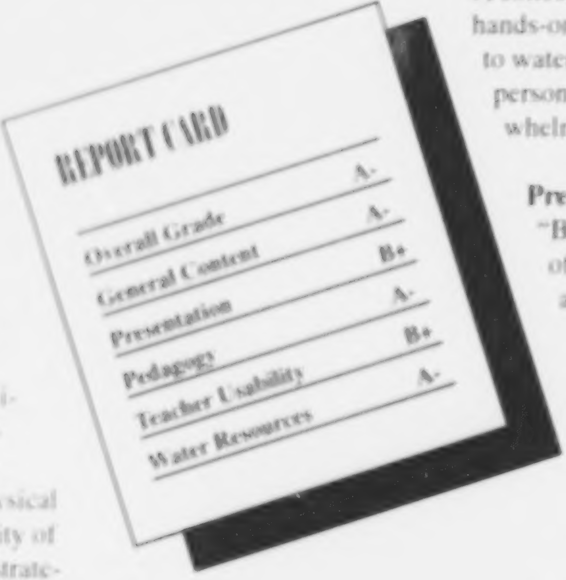
Project WET Curriculum and Activity Guide

The Watercourse and Council for
Environmental Education
c/o Montana State University
201 Culbertson Hall
Bozeman, MT 59717-0570
(406) 994-5392

Only available through training workshop. 1995. 516 pages.

Project WET is a national water education program designed to promote awareness, appreciation, knowledge, and stewardship of water resources. This guide reflects these goals in a collection of 91 interdisciplinary activities for K - 12. Content focuses on the human relationship with water, as well as the chemical and physical properties of water, quantity and quality of water, ecosystems, and management strategies. Extensive cross-referencing and planning charts, supplemental resource guide, and glossary are provided.





REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	B+
Water Resources	A-

COMMENTS

General Content

"A collection of innovative, water-related activities that are hands-on, easy to use, and fun!" Essentially all topics relevant to water resources are presented. "The provision of a support person in each state is helpful - the book is almost overwhelming in its scope."

Presentation

"Because the book is organized by subject area instead of grade level, it is hard to find the primary grade activities."

Pedagogy

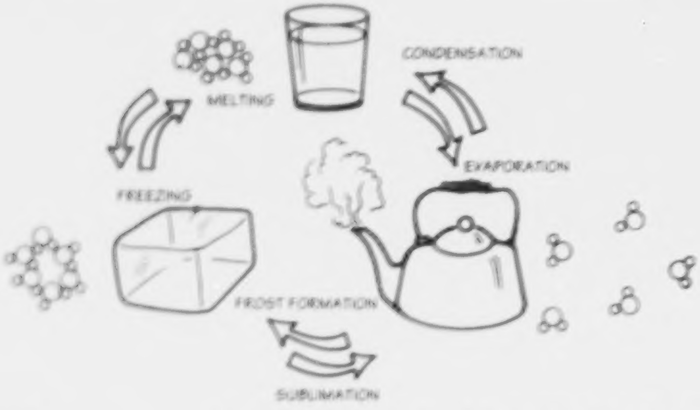
"While grade-level appropriate activities are offered, only one-fourth of the activities are geared for the primary level." Since several options are listed in each activity, this may be a more useful guide for a resource teacher.

Teacher Usability

"Not as teacher-friendly at the K - 3 level as it is in the higher grades." "The cross-referencing is excellent."

Specific Content on Water Resources

"A thorough coverage of water resources."



Procedure

▼ *Warm Up*

Show students the ice cube, glass of water, and cup of steaming water while identifying the state of each (solid, liquid, gas). Discuss the appearance of water in each of these states (e.g., snowflakes and ice are in the solid state, while steam is a gas).

Ask students if they saw water as a solid, liquid, or gas on their way to school (e.g., snow, rain, puddle, water evaporating from a heated sidewalk).

▼ *The Activity*

Part I

1. **Tell students they are going to match cards that have pictures of water as solid, liquid, or gas (e.g., solid with solid, etc.). Hold up the** *Water Match Cards* **(excluding the** *Polluter Joker* **and** *Washer Wild* **cards) one at a time. Ask students to identify the picture and the state they think the water is in** (e.g., a picture of a lake is water in its liquid state; a picture of a geyser or steaming kettle is gas).

2. **Divide the class into groups of four. Give each group a set of cards to be evenly distributed among players. Tell them to look at their cards without letting other players see them.**

3. **Discuss the rules of the game:**
- If any player is holding matching cards, he or she lays them down, face up. (An example of a match is the geyser and the tea kettle, because both pictures show water as a gas.)
- Decide who will go first, second, third, and fourth.
- The first player draws a single card from one other player.
- If the card matches, he or she lays the pair down and takes another turn.
- If there is no match, the second player takes a turn and draws from any other player.
- Continue taking turns until all cards are paired.
- The player with the most matches wins!

Part II

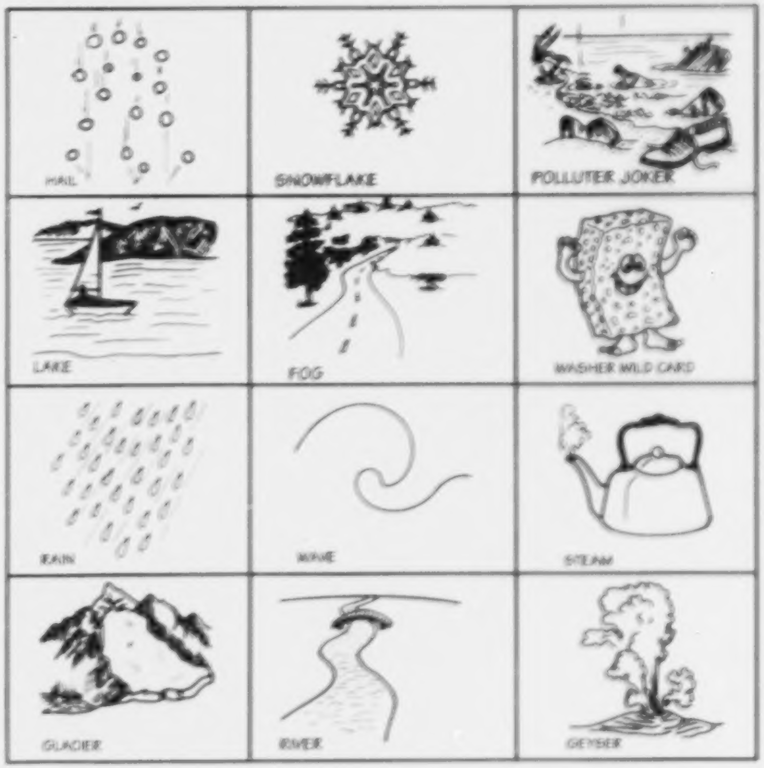
1. **Ask students to describe water pollution.** Discuss ways water can be polluted. How do they feel about pollution?

2. **Tell students they are going to play the game again, but a new card will be added. Show them the** *Polluter Joker* **card, and explain that this is a card they do not want.**

3. **Add a** *Polluter Joker* **card to each group's set of cards. When the cards are dealt, tell students that the one with the** *Polluter Joker* **card should not tell anyone else or he has it. The object is to get someone else to draw it. Continue playing until everyone has an empty hand except the one holding the** *Polluter Joker*.

4. **How did the players feel who ended up with the Polluter Joker card? Discuss ways pollution can naturally be removed from water and how humans have developed**

Water Match Cards

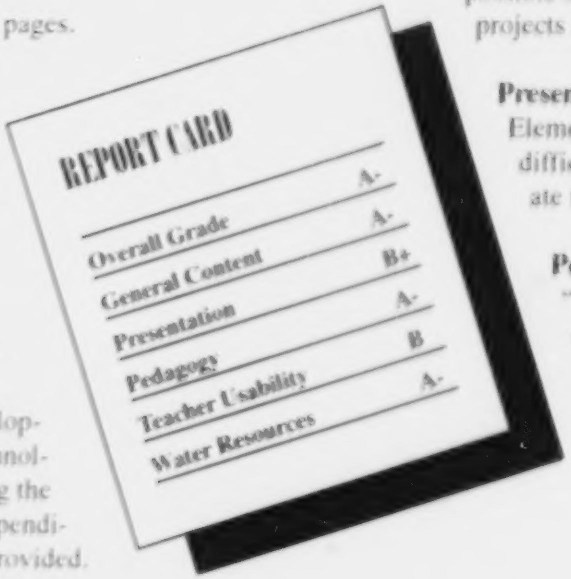


The Ways of the Watersheds

Frost Valley YMCA
2000 Frost Valley Road
Claryville, NY 12725-9600
(914) 985-2291

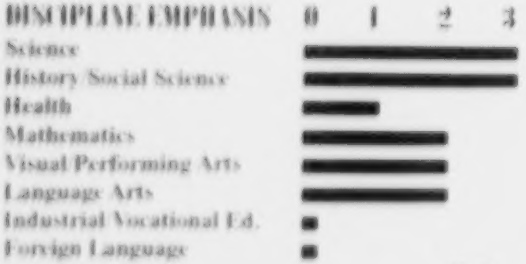
$20.00 and $5.00 shipping. 1995. 248 pages.

"The Ways of the Watersheds, an Educator's Guide to the Environment and Cultural Dynamics of New York City's Water Supplies" examines several aspects of watersheds, associated problems, and solutions. Sections include: The Hydrology of the Watersheds, The Geology of the Watersheds, The Ecology of the Watersheds, The Pollution Sources of the Watersheds, The Development Within the Watersheds, The Technology of the Watersheds, and Conserving the Quantities of the Watersheds. Two appendices and extensive bibliographies are provided. Although specific to New York, activities can be modified to work elsewhere.



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	B
Water Resources	A-



COMMENTS

General Content

This curriculum focuses on the problems of watersheds and possible solutions, offering lots of ideas for classroom action projects and opportunities for authentic assessment.

Presentation

Elementary activities are grouped together, making it difficult to identify a lesson that is specifically appropriate for one grade level.

Pedagogy

"The curriculum uses methods to help students gain an understanding and respect for their local environment." "Some lessons may have to be adapted for K - 3 application."

Teacher Usability

"Much of this needs to be taught on-site at a river system." "Would be a good curriculum for an outdoor school."

Specific Content on Water Resources

"In-depth coverage of the subject matter; some specific to the Catskills in upstate New York."

The Webs of Water

Grades: elementary
Objective: to demonstrate the inter-relatedness of the stages in the water cycle
Subjects: General, Earth and Life Sciences, Chemistry, Social Studies

Materials: A long length of string or yarn, paper and pencil

Information:

"When one tugs at a single thing in nature, he finds it attached to the rest of the world."
- *John Muir*

Often, it is difficult for students to comprehend a cycle that has stages that they are unable to witness first hand. Understanding the inter-relatedness of the steps of the hydrologic cycle from visible rain to invisible evaporation is possible through a combination of observation skills and group learning activities. The following activity is a helpful way for students to connect the steps of the water cycle in their minds as they connect a string to one another.

Procedures:

1. Begin by asking the students to stand in a circle.
2. Hand each student a piece of paper with a name from the list below, shuffling them as you hand them out.

The Webs of Water Characters

The Hot Sun
The Large Ocean
A Calm Lake
A Raging River
A Babbling Brook
A Fluffy Cloud
Heavy Rain
Light Snow
Thick Fog
A Small Puddle
Dry Soil
Deep Groundwater
A Large Oak Tree
A Thirsty Deer
A Sweaty Human

3. Give the group some time for each person to make up an action that represents the item on their card.
4. Using each student's motions and movements as clues, have the class guess the identity of each person. After each person's item is identified, hand the sun the end of the piece of string. Next hand a length of string to any character which has water that is effected by the sun's heat. With each hand-off, have the students explain their connection to the group. Continue making the connections between the characters, creating a web of string and ideas. For example: a series of connections may be, the sun to the ocean to a cloud to rain to the puddle. The web begins to appear as the group finds that many of the characters are related to many different characters of the cycle.

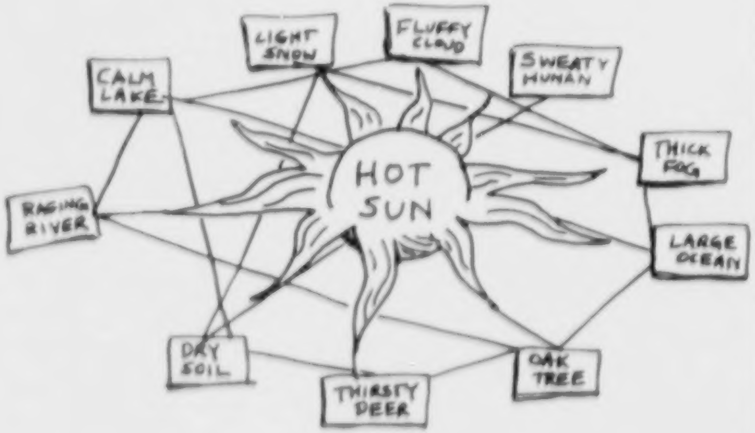
5. To aid the students in finding the relations and dependence between the items, propose the scenario that a drought entered the area so all of the forms of the precipitation disappeared. Have the rain, snow and fog students drop their lines and illustrate how everyone else is then affected.

Variations:

- Have the students find visual examples of condensation, evaporation and precipitation. An example of these terms may be a puddle disappearing in the sun or have the students breathe closely on a mirror or chalk board watching the condensation evaporate from the surface.
- Create a water cycle game of charades in which students act out stages of the cycle for the others to identify.
- Give each student an identity in a straightforward water cycle (i.e. solar radiation heats up water particles, water vapor rises, water vapor condenses on dust . . .) and have the group line themselves up in a circle illustrating the order of water cycle.

Watershed Discussion Questions:

- How do you explain the fact that there is the same amount of water today as there was 3 billion years ago?
- How do your daily actions affect the water cycle?
- Are there any events in your community that affect the water cycle?

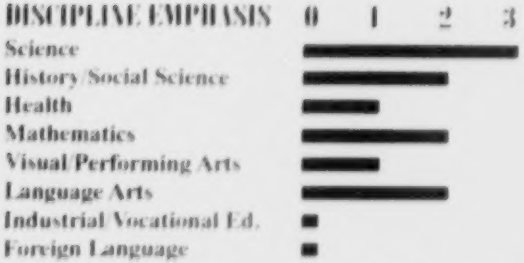


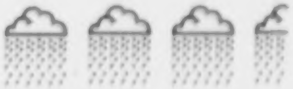
Aquatic Project WILD

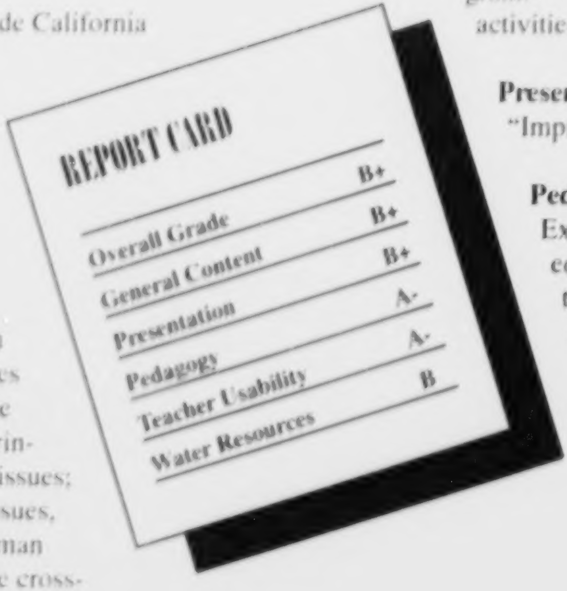
Council for Environmental Education
Distributed in California by:
California Department of Fish and Game
1416 Ninth Street
Sacramento, California 95814
(916) 653-3857; (301) 493-5447 outside California

No charge for book (provided at fee-based workshop). Attendance at a Project WILD workshop is a prerequisite for the Aquatic Project WILD workshop. 1995. 242 pages.

Recently revised, "Aquatic Project WILD" is an interdisciplinary and supplementary program based upon an exploration of water and aquatic species and habitats. Diverse activities explore awareness levels; values; ecological principles; management and conservation issues; people, culture, and wildlife; trends, issues, and consequences; and responsible human actions. Numerous appendices provide cross-referencing by skill, grade-level, and topic.







REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	A-
Teacher Usability	A-
Water Resources	B

COMMENTS

General Content

"*Aquatic Project WILD* is intended to be a supplemental program." "It serves as a well integrated water curriculum with activities that can be easily adapted to different grade levels."

Presentation

"Improved organization in the new edition."

Pedagogy

Extensive pilot testing has resulted in an improved new edition. "Lessons are well organized with clear objectives and a variety of methods to meet many learning intelligences."

Teacher Usability

"Easy to use, although many lessons need to be adapted for K-3."

Specific Content on Water Resources

The focus is more on aquatic wildlife than water resource issues. It does, however, discuss water use conflict and human impact of water use.

HOW WET IS OUR PLANET?

OBJECTIVES

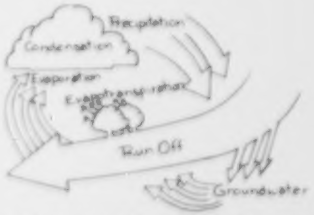
Students will: 1) describe the amount and distribution of water on the earth in oceans, rivers, lakes, groundwater, icecaps and the atmosphere; and 2) make inferences about the importance of responsible use of water.

METHOD

Students calculate water volumes using percentages.

BACKGROUND

The earth has been called the water planet. Between two-thirds and three-fourths of its surface is water. The earth's water can be seen in flowing rivers, ponds, lakes, oceans, locked in the northern and southern icecaps, and drifting through the air as clouds. Water that has seeped into the earth's crust (groundwater) is more difficult to see, yet all these forms of water are part of a dynamic interrelated flow that we call **the water cycle**. It is illustrated below.



Each of the segments of the water cycle shares a portion of the total amount of water on the planet.

Age: Grades 4-12
Subjects: Math, Science
Skills: computation, description, discussion, estimating, inference, interpretation, mapping, measuring, observation, psychomotor development, small group work, synthesis
Duration: 40 to 60 minutes
Group Size: any; individual and small group work
Setting: indoors
Conceptual Framework Reference: IA, IA1, IA2, IB, IC, IC1, IC2, IC3, IC4, ID
Key Vocabulary: water cycle, freshwater, saltwater, groundwater, earth, planet
Appendices: Ecosystems, Metric Conversion

Students tend to think of the water on the planet as being limitless and yet simple calculations demonstrate the fact that the amount of water is limited. Scientists believe that all the water that we will ever have is on the earth right now. Whatever amount is available to humans and wildlife depends largely on how its quality is maintained. Human beings have a responsibility to conserve water, use it wisely and protect its quality.

The major purpose of this activity is for students to acquire an understanding of how fragile a resource water actually is.

MATERIALS

a large display map of the world; a 12-inch diameter globe (one showing the ocean bottom is best); a five or ten-gallon aquarium, bucket, trash can, or other container; writing materials; calculators; measuring cup; one quart container for every three students; one measuring tablespoon for every three students

PROCEDURE

NOTE: Refer to the table in the Variations to this activity for the metric approximations.

1. Using a map of the earth, begin a discussion of how much water is present. Ask the students to comment on why the earth is called "the water planet." Call the students' attention to the statistic that between two-thirds and three-fourths of the surface is covered with water. After general discussion, provide the students with the following statistics:

Water on Earth

Oceans	97.2% of total
All icecaps/glaciers	2.0%
Groundwater	0.62%
Freshwater lakes	0.009%
Inland seas/salt lakes	0.008%
Atmosphere	0.001%
All rivers	0.0001%
Total	99.8381%

From The Doubleday Almanac. New York: Doubleday/Dolphin, 1985, page 114

2. Discuss the relative percentages. Do the calculations for them or ask the students to calculate the estimated amounts of fresh water potentially available for human use:

Groundwater	0.62%
Freshwater lakes	0.009%
Rivers	0.0001%
	0.6291%
including icecaps/glaciers	2.0%
	2.6291%

3. In discussing these figures, emphasize that the usable percentage of existing fresh water is reduced by pollution and contamination. Also, all the groundwater is not available and icecaps certainly are not readily available. Discuss the needs of humans for usable fresh water. Ask the students to consider what other life forms need both fresh and saline (salt) water.

4. Now show the students five gallons of water in an aquarium. Tell them how much is there. Provide the students with the following quantity: 5 gallons = 1280 tablespoons.

5. Have the students assume that the five gallons represent all the water on earth. Do the calculations for them, or ask the students to calculate the volume of all the other quantities on the water percentage list. This will require the use of decimals. Remind the students that for multiplication, all the decimal places must be shifted two places to the left so that 97.2% becomes 0.972 prior to multiplication, e.g. 0.972 x 1280 tablespoons = 1244.16 tablespoons. The following values result:

5 GALLONS

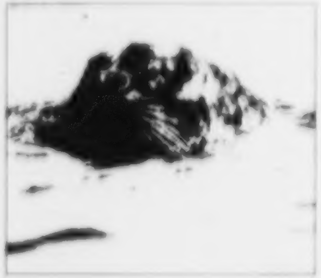
1.	Oceans	1244.16
2.	Icecaps/glaciers	25.60
3.	Groundwater	7.93
4.	Freshwater lakes	0.11
5.	Inland seas/salt lakes	0.1
6.	Atmosphere	0.0128
7.	Rivers	0.0012
Total		app. 1280 Tablespoons

6. Once the values are obtained, ask the students to calculate the volume of the water other than ocean water. (It is approximately 34 tablespoons.) Ask them to divide up in teams of three and put 34 tablespoons of water in a container and take it to their workplaces.

7. At their workplaces, ask the students to remove the amount of water represented by **all freshwater lakes and rivers.** (It is 0.111 tablespoons, approximately one-tenth of a tablespoon.) Then ask the students to extract the amount represented by rivers. (It is one-thousandth of a tablespoon.) This is less than a drop. Discuss the relative proportions with the students.

8. Consider the fragile nature of the freshwaters, wetlands and oceans of our planet. Discuss how all species depend upon this minute percentage of water for their survival. Summarize the activity by using an earth globe to illustrate that if the earth were this size (12 inches in diameter,) less than one-half cup (eight tablespoons) of water would fill all the oceans, rivers, lakes and icecaps. Close by emphasizing the importance of keeping the earth's waters clean and healthy and—when we do use waters—using them wisely and responsibly.

NOTE: For younger students this activity may be modified into a demonstration. It also can be modified into a step-by-step activity with a list of the quantities given the students.



© 1986 Western Regional Environmental Education Council

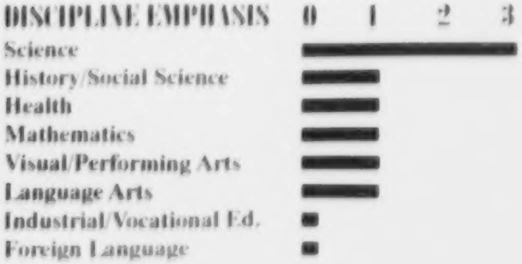
BEST COPY AVAILABLE

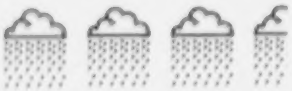
The Comprehensive Water Education Book

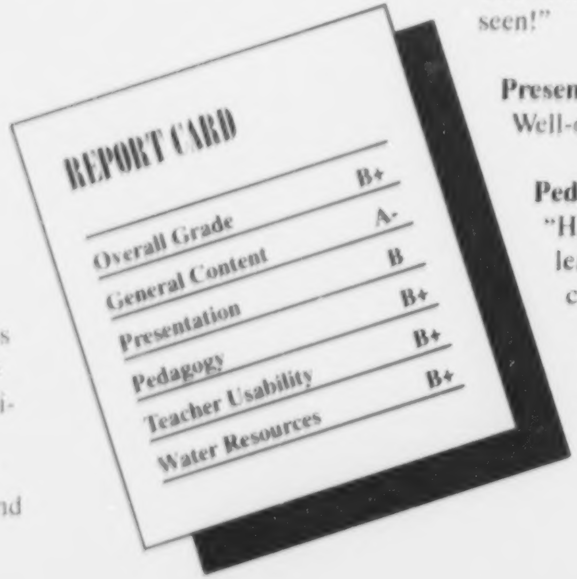
International Office for Water Education
Utah Water Research Laboratory
Utah State University
Logan, Utah 84322-8200
(800) 922-4693

$8.75. 1994. 335 pages.

"The Comprehensive Water Education Book" is designed to promote water literacy, specifically an understanding of water, water management, and water-related ecological and economic issues. Extensive teacher background sections are followed by lessons, which can be taught randomly or sequentially. Additional sections include supplemental resources, recreational activities, and recommendations for field methods and equipment.







REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B
Pedagogy	B+
Teacher Usability	B+
Water Resources	B+

COMMENTS

General Content
"One of the most interesting and well written curricula I have seen!"

Presentation
Well-organized material.

Pedagogy
"Hands-on and active learning emphasizes cooperative learning." "Cooperative groups are focused with task cards provided for the activities."

Teacher Usability
Teacher-friendly activities are presented. Needs recommendations regarding time required for each lesson.

Specific Content on Water Resources
"This curriculum covers almost every water resource issue - from chemical and physical characterisitics to the needs of living things."

Lesson One

Framework
Reference
1.11

WATER, SAND, AND MUD

Vocabulary:
- soak
- wet
- absorb
- dry

Grade: K-3

Purpose: This lesson is designed to introduce some of the basic properties of water to primary grade level children.

Materials

Activity One
- dry sand
- dry soil
- water
- soda straws
- pie tins
- various water containers
- paper towels

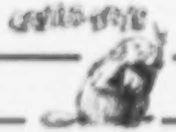
Activity Two
- medicine droppers
- water in paper cups
- waxed paper - 4" squares
- paper towels - 4" squares
- aluminum foil - 4" squares

Activity Three
- tape
- paper towels (plain white)
- medicine droppers
- colored water in plastic cups (red, blue, yellow)

Exploration

Activity One

1. Form cooperative learning groups. Have the **materials manager** for each group get a pie pan containing dry soil and another containing dry sand for the group. Instruct the **project director** to make sure that everyone has a chance to feel the material in each pie tin.
2. Have each **materials manager** get a container of water and two soda straws for the group. Show children how to pick up water with a soda straw by first placing the straw in the water and then placing a finger over the end of the straw. Instruct the **project director** to make sure everyone in the group first knows how to pick up water with the soda straw. Then everyone should have a chance to see what happens when water is slowly dripped on the soil and the sand.



Let the need for vocabulary grow out of the experience.

© Copyright All Rights Reserved

3. Discuss student findings. Put words like **dry**, **wet**, **soak**, and **absorb** on the chalkboard. Ask students what they think absorb means.

Have the **cleanup captain** supervise putting materials away.

Concept Development

1. Discuss student understanding of why some things **absorb** water, why some things get **wet**, and why other things stay **dry**. The discussion should trigger thought. Student answers need not be correct.
2. Indicate that the activity that follows is going to help the students learn more about absorb, wet, and dry. Reform cooperative learning groups.

Activity Two

3. Demonstrate the proper way to use a medicine dropper.
   - Press the bulb in.
   - Place the dropper end into the water.
   - Release the bulb.
   - Remove the dropper from the water.
   - To make drops, hold the dropper vertically and squeeze the bulb.

Proper use of scientific equipment should be taught as equipment is needed.

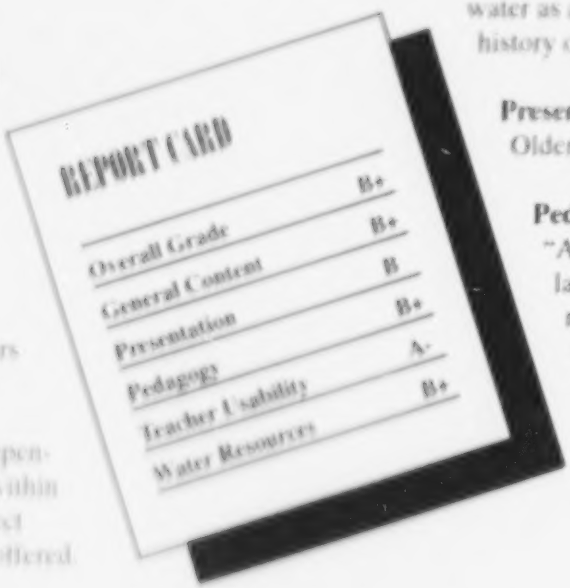
4. Have the **materials manager** get a paper cup with water, a medicine dropper for each person in the group, and a square each of paper towel, waxed paper, and aluminum foil. While the **materials manager** is obtaining the materials, provide the **project directors** with group instructions:
   - Caution people to be careful not to spill water.
   - Give everyone a medicine dropper.
   - The objective is to slowly drip water on the three materials to see what can be learned about absorb, wet, and dry.
   - Have each group talk about what they discover. You may wish to appoint a **reporter** for each group. This person could share the group findings with the entire class.

A Sense of Water

Southern Arizona Water Resources
Association
48 North Tucson Blvd., #106
Tucson, Arizona 85716
(520) 881-3939

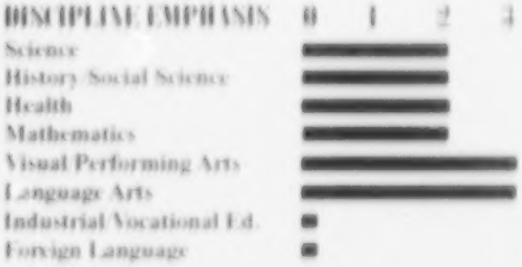
$10.00 plus $4.00 shipping. 1984. 134 pages.

"A Sense of Water" provides a broad range of water-related activities with particular emphasis on water availability in the arid Southwest. The activities are organized in six sections: Water Magic, The Wonders of Water, Less Water Climates, Water Working, Water Warnings, and Water Wisdom. Activities can be taught independently of one another or sequentially within a water unit. Glossary, topic and subject index, and conceptual framework are offered.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	A-
Water Resources	B+



COMMENTS

General Content

"'A Sense of Water' focuses on living in the desert and the use of water as a limited resource." "Native American legends and the history of Arizona are woven into student poetry and drama."

Presentation

Older - a 1984 publication date.

Pedagogy

"A strong visual and performing arts approach with some language arts." "K - 6 lesssons are all intermixed and are not sequential, although they are complete and easy to understand."

Teacher Usability

"Good background information for teachers, and easily reproduced maps and diagrams."

Specific Content on Water Resources

"The focus is upon living in the desert and understanding the impact of water." Many water resources issues are covered with a creative application.

402

Daily Currents

objective

Students will be able to:
- identify and [illegible] the ways that they use water every day.

materials

- flow chart to show a huge [illegible]
- drawing paper for each student
- crayons/colored pencils
- scissors
- paste
- large sheet of paper to make the [illegible]
- magazine pictures of [illegible] water use

background

[illegible]

introduction

Bring a huge raindrop [illegible]

Chapter Reference

[illegible]

Grades

K–3

Subject

Science, Social Studies

Length of Activity

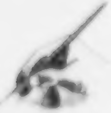
One classroom period

Concept

[illegible]

Key Vocabulary

[illegible]



notes

activity

Teacher: We are going to be detectives today and find out how many ways each of us uses water every day. I have drawn a huge raindrop to fill it up.

Tell me how you used it this morning:
brush teeth, wash face
at school: flush toilet, wash hands
for fun: [illegible], drink, etc.

Encourage all to participate. Fill up the raindrop.
- Encourage verbal participation.
- Create an awareness of how often each student depends on water throughout the day.
- This activity may continue to another time of day: add to it if someone comes up with another water use.
- If pictures are used, leave the poster up for several days. Use a title for the poster, like WONDERFUL WATER.
- Have the students draw pictures of how they use water. Paste pictures on a huge raindrop, or have students cut out pictures from magazines to add to the giant raindrop.

closure

Talk about how many other ways water is used by someone else to provide us with the things we eat, wear and use each day. Generate a list of twenty or more. Have the students choose those that are most important to them.

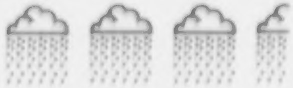
evaluation

Each student should be able to name a minimum of 5 ways he or she uses water.

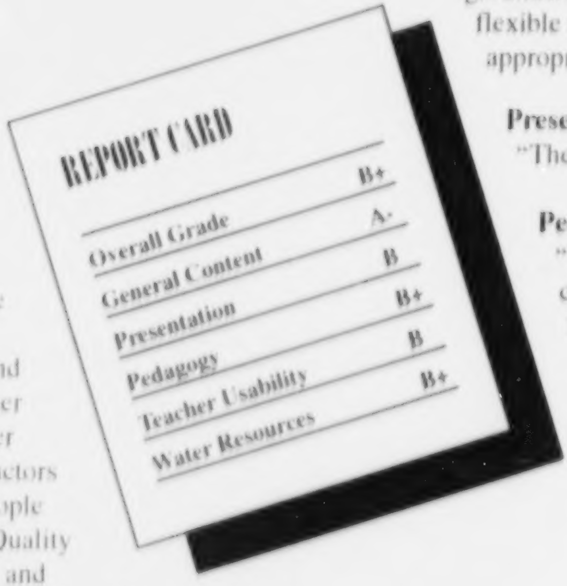
Gee-Wow! Adventures in Water Education

The Ecology Center of Ann Arbor
117 North Division Street
Ann Arbor, Michigan 48104
(313) 995-5888

$12.00. 1996. 70 pages.

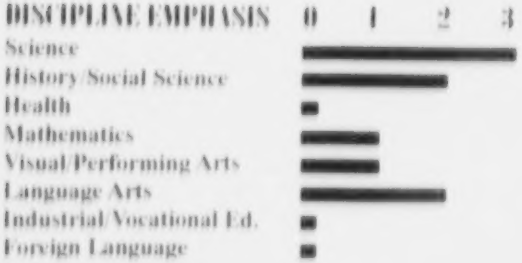


"Gee-Wow! Adventures in Water Education" teaches concepts related to water, groundwater, and pollution prevention. Activities are grouped into eight sections, as well as cross-referenced by subject area, activity type, and grade level. The sections are entitled Why Is the Earth Called the Water Planet?, How Is Water Stored and Moved in Planet Earth?, Where Is Water Found Underground?, How Does Water Move Underground?, What Natural Factors Influence Water Quality?, How Do People Affect Groundwater?, How Does the Quality of Groundwater Affect Life on Earth?, and How Can We Protect the Quantity and Quality of Groundwater?



REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B
Pedagogy	B+
Teacher Usability	B
Water Resources	B+



COMMENTS

General Content

"This is a thorough curriculum on water and specifically on groundwater with in-depth and well organized lessons." It offers a flexible structure, enabling a teacher to expand coursework where appropriate.

Presentation

"The format is teacher-friendly."

Pedagogy

"The curriculum offers a variety of lessons... students could benefit from more opportunities for discovery, however."

Teacher Usability

Each lesson is appropriate for four different grade levels, thus requiring that teachers make adjustments, particularly at the lower primary level.

Specific Content on Water Resources

The majority of this curriculum focuses on groundwater - use, quality, and effects of pollution.

Ground *What?* Groundwater!:

How water fits underground

Adapted with permission from "What Is Groundwater?", Groundwater Quality Protection in Oakland County: A sourcebook for teachers, East Michigan Environmental Action Council, Birmingham, MI, 1984

SUMMARY: Students, working in groups, build a simulated aquifer, identify the water table, and learn how water is stored underground.

OBJECTIVES: To explain that groundwater fills the spaces between particles, and to learn about the water table.

VOCABULARY WORDS:
groundwater, water table, saturated

TIME REQUIRED: 20 minutes

MATERIALS NEEDED:
Each group of 3-5 students needs:
1 Clear cup filled to the top with pea or aquarium gravel and half-filled with water
1 Clear cup filled halfway with sand
1 Cup filled 1/3 with water
1 Crayon or 2 pieces of tape

PROCEDURE:

1. Divide students into groups and hand out cups containing gravel and water. Ask students to examine the material in their cup and describe where the water fits in it *(between gravel particles)*. Explain that water found in the ground is groundwater. This is like the water found under the earth's surface.

2. Have each group find the top of the water in the cup, and using a crayon or piece of tape, mark it on their cup. Explain that this is the water table.

3. Distribute one cup of sand, and one cup of water to each group. Have students examine the sand for things like particle size, color, texture, etc., and share their observations with their group.

4. Students should slowly pour the water into the cup of sand. Those not pouring should be carefully observing where the water goes. *(It fills up the spaces between the sand particles.)* They should also watch for the telltale bubbles of air that may form as air is being forced out of the spaces between particles by the incoming water.

5. Ask students to mark the water table in the cup of sand and water with a crayon or tape.

6. One student in each group should make a hole in the sand with their finger or a pencil. A small pool of water will form in the hole. The top surface of the water in this pool is the water table.

7. Have students feel the sand on the top. How does it feel? Why? *(The sand at the top of the cup is dry or damp. It is not saturated, like the sand under the water table.)*

8. Have students poke a hole in the bottom of their cups, and let the water drain out the bottom. Then, feel the sand. Is it dry or damp? *(Damp)* Why? *(Because some water sticks to the grains of sand.)*

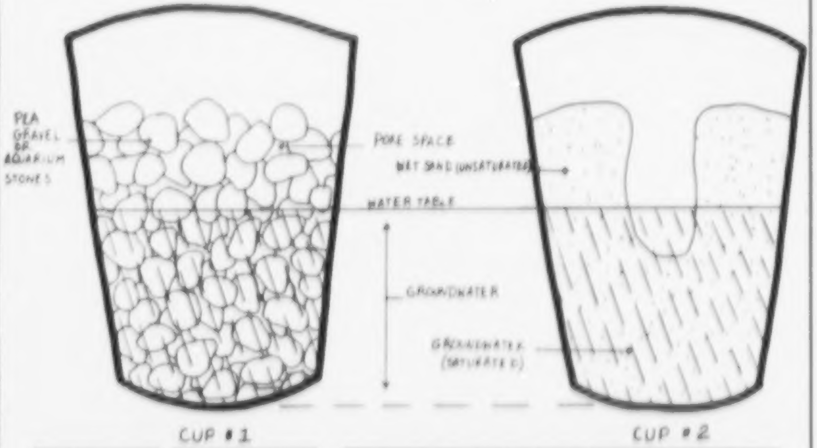
9. Discussion Questions

a) What happens to the water that comes down when it rains or snows? *(It runs off into lakes or ponds, evaporates into the air, or sinks down into the ground and travels to the water table. In Michigan, about 30% of precipitation reaches the water table.)*

b) What was between the sand or gravel particles before water was poured into the cups? What is between sediment particles underground if there is no water there? *(Air, which is displaced by the water.)*

c) How far underground is the water table? *(The depth of the water table varies with the area. In most lakes and streams, the water table is visible to people. In other places, it can be just a few to several hundred feet under the ground.)*

d) Why is a water table important to life on Earth? *(People use wells to reach the water table and draw up water. When the water table is at the surface, as with lakes and streams, all the plants and animals in the lake or stream depend on the water in the water table to exist in their habitat.)*



BACKGROUND:

When water hits the ground, gravity pulls it through the pores in the soil until it reaches a depth where all of the spaces between the particles are filled with water. The water level at this point is called the water table. The water table can be affected by various factors. It can rise during high periods of rainfall, and fall during a drought.

Below the water table, all the spaces between particles are filled with water, also known as groundwater. When there is an underground, saturated, permeable, geologic formation capable of producing significant amounts of water in a well or spring, it is called an aquifer. There are two types of aquifers.

Nearly 90% of all aquifers developed for water supplies are composed of sands and gravels. Porous sandstone, limestone and highly-fractured crystalline and volcanic rock are other common aquifer materials.

BEST COPY AVAILABLE

Water Precious Water

AIMS Education Foundation
P.O. Box 8120
Fresno, California 93747-8120
(209) 255-4094

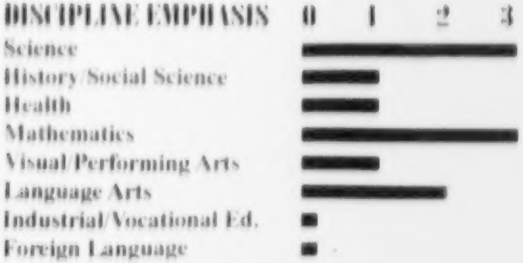
$14.95. 1988. 91 pages.

Produced by AIMS Education Foundation in cooperation with the California Department of Water Resources and Irvine Unified School District, "Water Precious Water" integrates mathematics and science to teach students about water concepts through an application of skills. Twenty-nine hands-on activities explore physical and chemical properties of water, water treatment and distribution, and water quality and conservation.

REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B+
Teacher Usability	A-
Water Resources	B-

DISCIPLINE EMPHASIS



COMMENTS

General Content

Excellent integration of mathematics and science in "fun, hands-on activities." Although environmental education is not the basis for this curriculum, it offers a variety of lessons which could be integrated into other curricula.

Presentation

"Excellent reproducible material and engaging graphics."

Pedagogy

"Experiment-oriented lessons provide for active learning and are easily adaptable to most classroom situations." "Good data gathering activities."

Teacher Usability

Very teacher-friendly.

Specific Content on Water Resources

"Water Precious Water" provides a broad overview of water resource topics, although not necessarily within the context of environmental education.

Lesson plans are copied with permission of the AIMS Education Foundation.

POND TODAY — MEADOW TOMORROW

I. Topic Area
Evaporation

II. Introductory Statement
This activity will show students how physical and biological processes interact to produce changes in the environment as they simulate a pond turning into a meadow as the water evaporates

III. Math Skills	**Science Processes**
a Counting	a Classifying
b Graphing	b Predicting
c Measuring	c Collecting and recording data
	d Controlling variables

IV. Materials
aquariums or large plastic containers
soil
rye grass seed or birdseed
three varieties of water plants
metric rulers
activity sheets

V. Key Question
What happens as an aquatic environment changes to a land environment?

VI. Background Information
Our environment is constantly changing as a result of the interaction between physical and biological processes. We call this change succession. It is a slow process that occurs continuously.

VII. Management Suggestions
This is a long term activity that will take approximately three weeks. A schedule should be set up that allows time to observe and record results every three days. This activity can be done in groups or as an entire class. Aquariums or large plastic containers work best for this activity, but two liter plastic bottles with the tops cut off will also work. The soil in the containers should be sloped, with part of the soil above the water line and part of the soil below the water line. Aquatic plants can be found at pet stores or anywhere that fish and aquariums are sold.

VIII. Procedure
1. Put a layer of soil in the container and make it slope steeply from one side of the container to the other. Add enough water so that half of the soil is above the water line and half is below.
2. Count out ten seeds and sprinkle them in the container. Some of the seeds may fall on the dry soil and some in the water.
3. Place three different aquatic plants in the water. Draw a picture on the activity sheet showing what the environment looks like.
4. Every three days sprinkle ten more seeds into the container.
5. Measure and record the water level. Do not add more water.
6. Count and record the total number of seeds that are growing. Check the three water plants and record whether they are alive or dead.
7. On days 5, 10 and 15 draw a picture of the environment on the activity sheet.

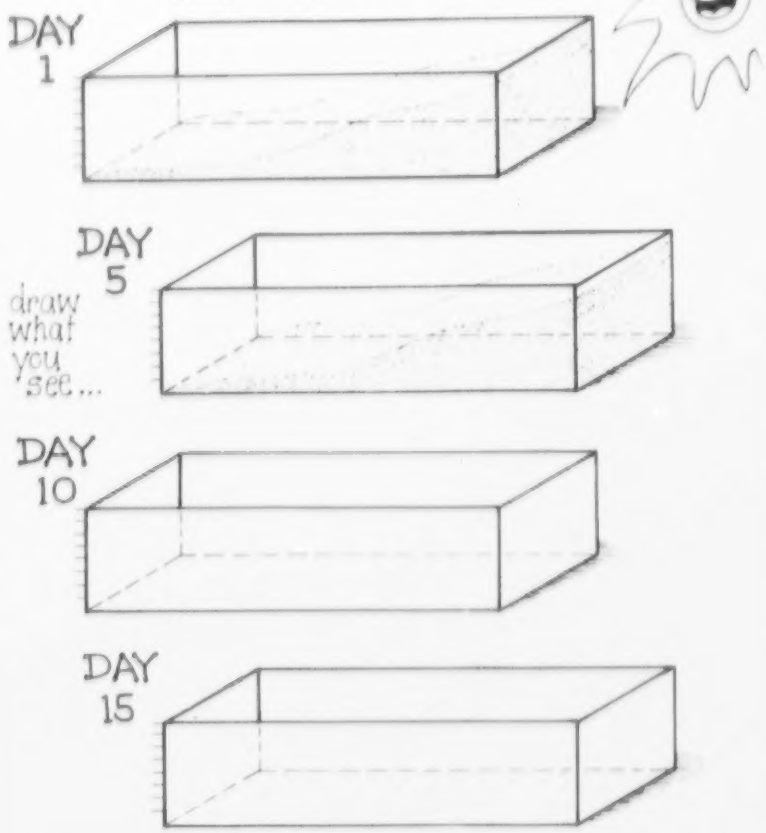
IX. Discussion Questions
1. Discuss the questions on the activity sheet.
2. How do seeds get spread in nature?
3. How would pollution change the environments?

X. Extended Activities
1. Make another pond environment and deliberately pollute it by adding things like salt, oil, soap, etc.
2. Allow all the water to evaporate and then add more water to simulate flooding. See what happens to the land plants as they are submerged for a period of time.

© 1988 AIMS Education Foundation

Copyright AIMS Education Foundation

POND TODAY...MEADOW TOMORROW



1988 AIMS Education Foundation

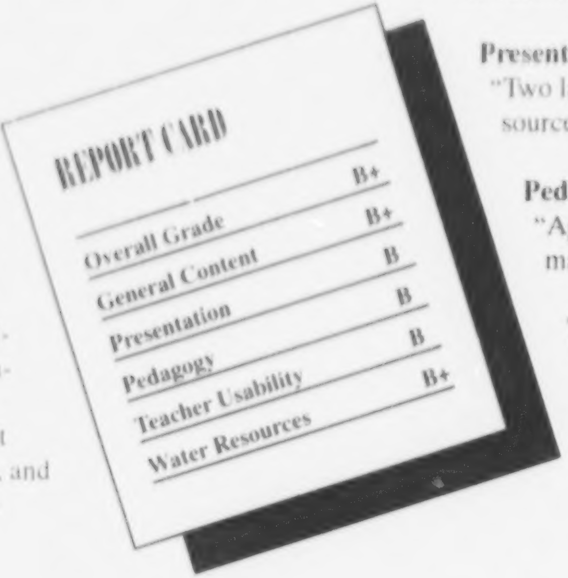
Copyright AIMS Education Foundation

Water Is Your Best Friend

Department of Water Resources
Publications Office, Room 338
P.O. Box 942836
Sacramento, CA 94236-0001
(916) 653-1097

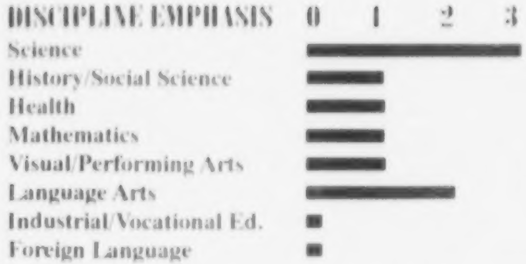
No charge. 1979. 35 pages.

Accompanied by the flannel board stories, "Water Is Peter's Best Friend" (revised in 1993) for grades K - 2 and "Peter's Magical Water Journey" (revised in 1995) for grades 2 - 4, " Water Is Your Best Friend" offers eleven concrete, experiential water conservation and reclamation activities. Activities are divided into three sections: Water Is Your Best Friend, Water Wears Three Costumes, and Take Care of YourFriend Water. Two poster maps are included.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B
Pedagogy	B
Teacher Usability	B
Water Resources	B+



COMMENTS

General Content

This developmentally-appropriate curriculum encourages personal stewardship of water resources through a creative avenue.

Presentation

"Two large posters, 'Water Cycle' and 'California Water Resources' are excellent visuals."

Pedagogy

"Age-appropriate activities combine with easily accessible materials for hands-on experiences."

Teacher Usability

"A major component of the curriculum is a flannel board, requiring lengthy preparation of materials."

"The 2-4 level flannel board may be better used as a story older students tell younger students or as a script for a play."

Specific Content on Water Resources

"A major emphasis of the curriculum is on the water cycle."

Procedure 2: When the drop has evaporated (disappeared) discuss children's suggestions for bringing it back. When cooling is suggested, set the glass in the bowl of ice water. Since our water drop likes to hide, we may have to wait 10-15 minutes. While waiting, ask: What made our drop of water jump into hiding? (warm air) When liquid water turns into water vapor, what word do we use? (evaporation) Recall use of term in Lesson 1. What are we using now to make the water drop come back? (cooling) What does cooling do to water vapor? It makes the tiny particles or molecules condense or get closer together.

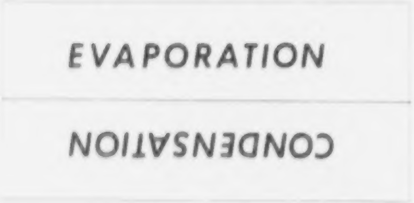
Introduce the word condensation by writing it on the board. Then say it together and clap out the syllables. Repeat the illustration (Lesson 1) of condensation-evaporation by asking a child to exhale on the blackboard, or window. Outline the dark spot made by moisture from the breath. Ask children to breathe out. Why doesn't this moisture show now? The water droplets jump away into the air around you. What made them show on the blackboard as a dark spot? Ask a child or two to touch the blackboard, then hold your hand in front of your mouth. Which is cooler? (the blackboard) What did we do to our glass to bring back the water drop? We cooled it with ice water.

Extension: How could we act out evaporation or condensation?

Ask your friends to guess which you're acting out (e.g. fanning something-evaporation or blowing on a window-condensation).

Materials: A piece of newsprint (plain) for each child

Procedure: Children fold the sheet in half. Label one half condensation, the other, evaporation. Let individuals or small groups plan and act out an activity to demonstrate one or the other. The other children hold up the correct



Procedure (continued): word on their papers to show they recognize the process being shown.

Extension 2: Children may enjoy acting out liquid water molecules, walking about in a small group. Others may act out water vapor molecules, moving faster, e.g., running on the playground. Ask: How would you act out water molecules in snow or ice? (standing close together, moving slowly).

So What? Cooling invisible water vapor drops slows the molecules and brings them back in a more condensed form as liquid water (condensation). Heating liquid water speeds up the molecules, spreading them further apart and making them invisible again (evaporation).

LESSON 3 What Is the Water Cycle?

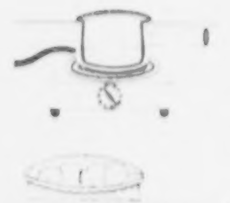
Key Idea: Water changes form to water vapor as the surrounding temperature rises, and cools back to liquid, and cools still further to snow or ice, warms back to liquid, and around and around, a never ending cycle without which we would quickly run out of water.

Activity: How can we use water to make a cloud?

Materials: Hot plate

Saucepan

Ice cubes



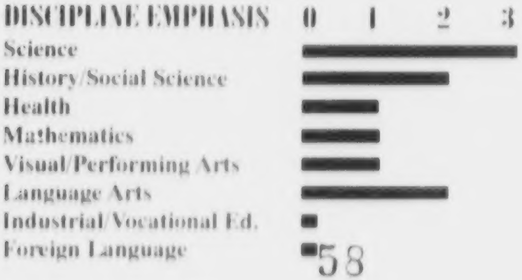
Procedure: Put ice cubes in saucepan on hot plate. As helper children watch ice melt, ask: What is making the ice turn back into water? (warmth) If we let the water from melted ice boil, what third form will water molecules take? (water vapor) As the water vapor rises, will it get warmer or cooler? (cooler outdoors) Children may wish to share experiences of cooler air in the mountains.

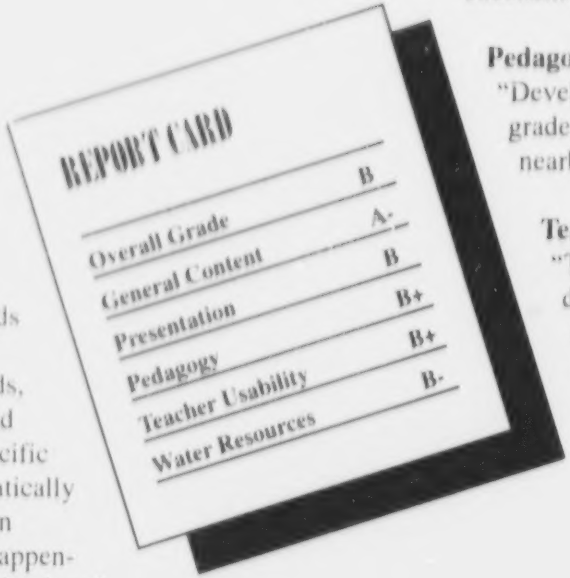
WOW! The Wonders of Wetlands

Environmental Concern, Inc., and
The Watercourse
c/o Montana State University
201 Culbertson Hall
Bozeman, MT 59717-0570
(406) 994-5392

$15.95. 1995. 330 pages.

"Wow! The Wonders of Wetlands" is divided into two core parts: an extensive teacher background section followed by 44 activities organized within five chapters: An Introduction to Wetlands, The Wetlands Community, The Role of Water in Wetlands, The Role of Soil in Wetlands, and Wetlands and People. Background information is cross-referenced to specific activities, designed to be taught thematically and cross-disciplinarily. A glossary, an educational resources section, and an appendix detailing plans for developing a schoolyard wetland habitat are also included.





REPORT CARD

Overall Grade	B
General Content	A-
Presentation	B
Pedagogy	B+
Teacher Usability	B+
Water Resources	B-

COMMENTS

General Content
"This offers extensive teacher background combined with an excellent planning guide."

Pedagogy
"Developmentally inappropriate for K-1; better suited for upper grades through high school, particularly if a wetland site is nearby."

Teacher Usability
"This is an excellent resource for a teacher wanting to develop a program utilizing a nearby wetlands." "Extensive teacher background information is provided." "Well organized; easy to pick up and plan."

Specific Content on Water Resources
An invaluable resource for teachers, naturalists, and youth group leaders interested in wetland curriculum development.

Wetlands in the Classroom!

Grade Level
K-8

Subject Areas
Life Science, Biology, Art

Duration
Teacher's discretion

Setting
Classroom

Skills
Gathering and organizing information

Charting the Course
After creating your own wetland community, try other introductory activities such as "Let the Cattail Out of the Bag," "Introducing Wetlands," "Wetland Metaphors," "Marsh Market," and "Wet 'n' Wild."

Vocabulary
wetland, adaptations, cypress swamp, cypress knees, marsh, cattail, fiddler crab, brackish water

Summary

What better way could there be to study wetlands than to have one right in your classroom!

Students create a "life-size" cypress swamp or display, or nurture wetland plants and animals in an aquarium or terrarium.

Objectives

Students will:

- gain greater insight about what makes up a wetland.
- describe a wetland community as a whole.

Materials

- *pictures or posters of wetlands and wetland plants and animals (see resource list, p. 326).*
- *reference books*

*For **Part I**:*

- *large rolls of colored bulletin board paper or posterboard*
- *egg carton cups*
- *fishing line*
- *construction paper*
- *tape*
- *scissors*
- *crayons*
- *markers*
- *paint and brushes*
- *scraps of tissue paper, yarn, and fabric*
- *ladder*

*For **Part II**:*

- *10- to 20-gallon (36- to 76-l) aquarium*
- *filter*
- *bubbler*
- *screening for container cover*
- *aged tap water*
- *sea salt mix from an aquarium store*
- *gravel, sand, or mud*
- *plants (preferably not taken from a wetland but purchased from a nursery that sells wetland plants. See page 304 for a listing.)*
- *animals collected by students or purchased from a biological supply company*
- *food for collected animals*

Making Connections

Any of us may be faced with significant decisions that ultimately affect wetlands. Our ability to make sound choices depends on the understanding factors that allow wetlands to thrive. Sometimes it isn't until we define all parts of the big picture that we begin to understand the importance and function of all the puzzle pieces. By investigating the components of a cypress swamp and a terrarium or aquarium, students gain a greater appreciation of the interactions among the various biological and physical components of an ecological community.

Background

The Cypress Swamp: There are different kinds of swamps. A swamp may contain trees or shrubs, and certain species may predominate. A cypress swamp supports primarily bald cypress trees.

Bald cypress trees have needles, like pine trees, but they are deciduous, meaning the needles drop off in the fall. Cypress trees can grow in standing water and have developed unusual adaptations for living in such a situation. The bases of the trees are fluted or buttressed for aeration and better support. Bald cypress trees also have "knees," extra roots that grow up out of the water that may aid in oxygen gas exchange.

© The Watercourse and Environmental Concern Inc. 1995

Cypress swamps can be found on the East Coast from Florida to Delaware; along the Gulf Coast to eastern Texas and northward into Arkansas and Tennessee; and in the Mississippi Valley to southern Illinois and Indiana.

Although cypress swamps seem widespread, many people are unfamiliar with these areas of timeless beauty. "Spanish moss seems to drip from tree limbs, creating an eerie atmosphere in the darkness beneath the tall, looming trees. The scene is serene, but not quiet, as a green heron "lurks in the shadows of buttonbushes rimming tea-colored pools; painted turtles bask on moss-, cypress knee islets; and warblers, vireos, wrens, and bullfrogs join in a chorus accompanied by the rattling drum of pileated woodpeckers" *[Quote above from "Knee Deep" in* Virginia's State Parks . . . Your Backyard Classrooms, *Virginia Department of Conservation and Recreation, Richmond, VA.]*

Aquariums and Terrariums: An aquarium is a glass-sided tank or bowl in which fish or other living animals are kept. A terrarium is a glass container, usually enclosed, for growing and displaying plants. Learn how to build them in Part II of this activity.

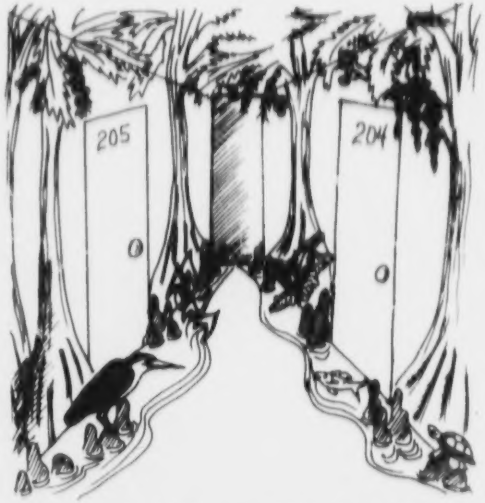
Procedure

To create your own cypress swamp, use the diagram and instructions below.

In addition to or as an alternative to building a wetland scene, construct and maintain a wetland aquarium or terrarium. You can have a fresh, brackish, or salt-water wetland living right where your students can watch it every day!

Warm Up

Show the class pictures or posters



of different types of wetlands, including the cypress swamp, or have them research wetlands on their own. The choices include saltwater or freshwater marshes, bogs, swamps, bottomlands, mangrove swamps, potholes, and even wetlands created by beaver dams. Ask students to identify the components that differentiate cypress swamps from other wetlands. What would they need to build their own wetland?

The Activity

Part I: ***The Cypress Swamp***

1. **Explain that the class will be working together to create a large scene of a wetland, complete with plants, animals, and (of course) water.** Students may want to vote on the type of wetland to depict.

2. **Help the students make a list of all the plants and animals they could include in their scene. Let the students choose the parts they wish to create. Use the following list as a guide:**

- ***The Swamp Backdrop***
Line the school hallway with a cypress forest! Use the large rolls of colored bulletin board paper to cut out life-size tree trunks that stretch to the ceiling. Make the trunks about one foot wide at the top and flared at the bottom. Tape the tops of the trunks to the walls and the bottoms of the trunks to the floor about a foot from the walls, so they stand out. Extend the tops of the trees onto the ceiling and make some branches that hang down. The leaves are needlelike, and round, green "cones" dangle from the limbs.

60

61

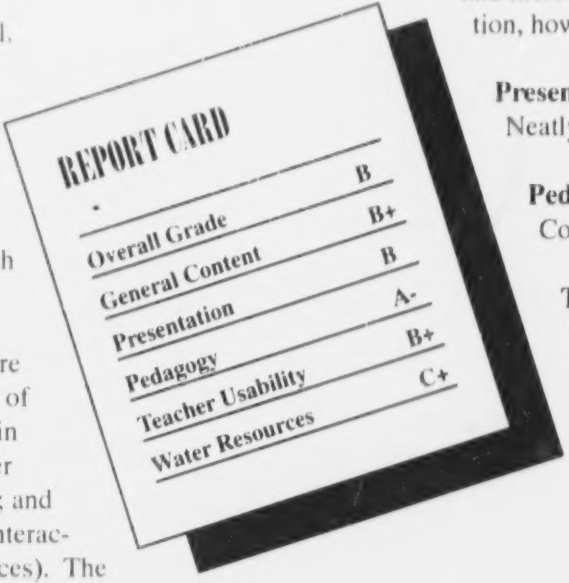
FOSS Water Module

Britannica Science System
Encyclopaedia Britannica Educational Corp.
310 South Michigan Avenue
Chicago, IL 60604
(800) 554-9862

🌧 🌧 🌧

$469.00. 1993. 2 box format. Bilingual.

Created by Lawrence Hall of Science, the "FOSS (Full Option Science System) Water Module" consists of 14 leaflets packaged in a Teacher's Guide (binder format), spiral bound index and English/Spanish glossaries, laboratory equipment, videos, and multimedia materials. Four hands-on and multisensory activities are featured: The Water Works (properties of water); Hot Water, Cold Water (water in liquid, solid, and gaseous states); Water Vapor (evaporation and condensation); and Testing the Water (water quality and interactions between water and other substances). The "FOSS Water Module" was evaluated without its laboratory component for the purpose of the compendium.



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	A-
Teacher Usability	B+
Water Resources	C+

COMMENTS

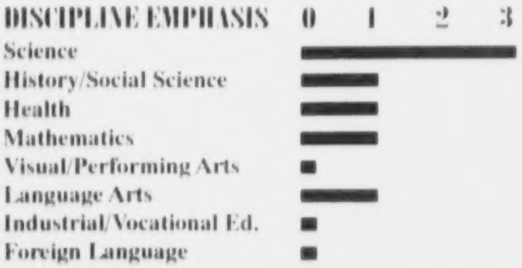
General Content
Designed for grades 3 - 4, the "Water Module" is self-contained and includes multimedia options. "It is not environmental education, however, but rather a physical science unit on water."

Presentation
Neatly-packaged program.

Pedagogy
Cookbook-style lesson plans.

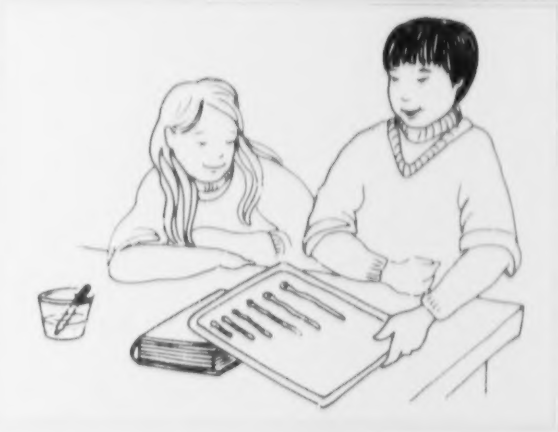
Teacher Usability
"Extremely teacher-friendly. Everything is packaged together, including helpful activity outlines."

Specific Content on Water Resources "This curriculum is very science-oriented. Careful experiments leave no room for studies of conflict or water issues."



THE WATER WORKS

ACTIVITY 1



STRAND

Earth Science

SCIENCE CONCEPTS

Earth material
Flow
Property
Surface tension
Water

SCIENCE THINKING PROCESSES

Observing
Communicating
Comparing
Organizing

INTERDISCIPLINARY ACTIVITIES

Language
Mathematics

PURPOSE

In *The Water Works* the students will

- Observe properties of water
- Observe and explore the property of water surface tension
- Observe the movement of water on a slope
- Learn concepts that will contribute to understanding of the following themes: **Pattern** and **Structure**

THEMES

Pattern
Structure

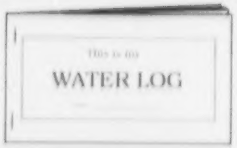
OVERVIEW

In *The Water Works* students conduct investigations to observe properties of an important earth material: water. They compare the way water interacts with four different materials: wax paper, paper towel, aluminum foil, and writing paper. They find out how many drops of water they can place on a penny before the water spills off.

Following these experiences the students are introduced to the water property of surface tension, and use detergent to weaken the surface tension. Finally, the students make six beads of water of varying sizes and compare how fast they flow down a slope.

GETTING READY

Be prepared for the possibility of wet *Water Logs*. If the students write after the experience, it will be easier to keep the logs dry, but the students won't have their materials at hand for reference.



STUDENT SHEETS

This is my
WATER LOG

LOOKING AT WATER

SURFACE TENSION

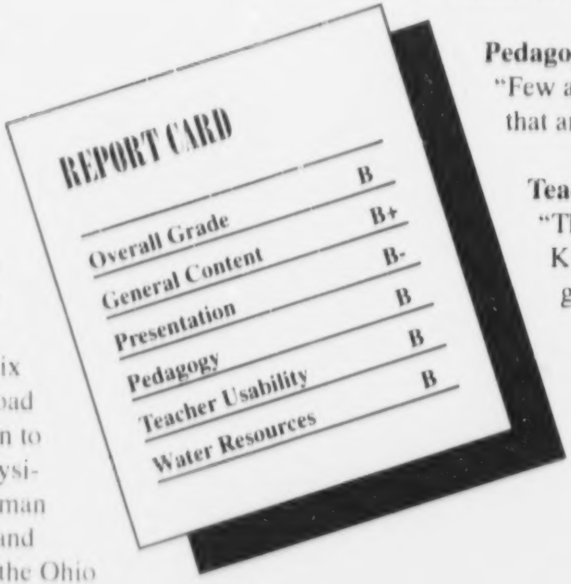
WATER ON A SLOPE

Always a River

United States Environmental
Protection Agency
Attn: Helen Fischer
Office of Research and Development
26 West Martin Luther King Drive
Cincinnati, Ohio 45268
(513) 569-7781

No charge. 1991. 284 pages.
Quantities are limited.

"Always a River, a Supplemental Environmental Education Curriculum on the Ohio River and Water" offers a series of activities that focus on the Ohio River and its importance to the six states through which it flows. Four broad units explore the Ohio River in relation to the total ecosystem; the biological, physical, and chemical aspects of water; human use of and impact on the Ohio River; and historic influence and implications of the Ohio River. Although regional in focus, activities can be modified to work elsewhere.



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B-
Pedagogy	B
Teacher Usability	B
Water Resources	B

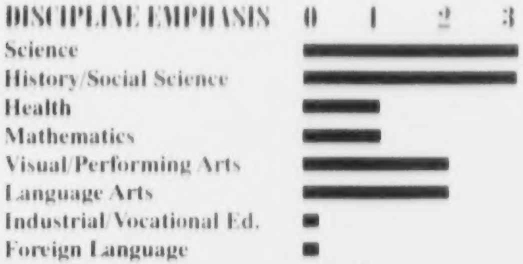
COMMENTS

General Content
"A great historical document." "Hands-on activities explore the historical and cultural development of the Ohio River."

Pedagogy
"Few activities (18 of 58) are appropriate for K - 3, and those that are focus on art and language arts."

Teacher Usability
"The K - 12 lessons are intermixed, making it difficult for K - 3 lessons to be sequenced." "A lot of teacher background information is provided."

Specific Content on Water Resources
"Issues are relevant to the Ohio River region, but could be applied to California river systems with some research."



66

Activity

Make an Imaginary River System

Objective	Students will construct their own miniature river systems and be able to explain the concepts of watersheds and tributaries.
Setting	Indoors
Duration	One 1/2 hour art session and one 1-hour creative writing assignment
Subject	Art, Language Arts, Social Studies
Skills	Writing, Psychomotor Development, Observation, Comparing Similarities and Differences, Inference, Discussion, Media Construction
Grade Level	K-6
Vocabulary	tributary floodplain
Background Information	Refer to Unit I, Section A-1.

Materials

- Construction paper
- Nontoxic, water soluble ink or thin paint
- Straws
- Newspaper, aprons, and protective covers for furniture and children

Procedure

In preparation for this activity, cover furniture and outfit children with smocks or other protective clothing. Cover working surfaces with newspaper.

1. Pass out a piece of art paper and a straw to each student.
2. Put a small puddle (several drops) of ink or paint at the edge of each piece of paper.
3. Have students blow directly onto the ink or paint through the straw. Be sure that student is blowing into the side of the drop from the same level as the paper, not down on top of the drop. The ink/paint drop should spread out in a branching pattern similar to that of a river and its tributaries.

Procedure *(continued)*

4. Tell students that they have made an imaginary river system. The force of their breath served as the wind or a force of nature to make the paint/ink (river source) drain or run onto other areas of the paper (land). They should name their river and its major tributaries. Have students label their work with their name and the name of the system and put it aside to dry.

For homework, ask students to think about whether their rivers are "wild" or "settled." If settled, are there any towns or cities along the river and its tributaries? Any natural areas? How do people who live in the river system use the water?

Conclude with a discussion of what other forces of nature (rain or snow storms, mountains, gravity, glaciers) might act upon water to form a river system.

Extension/ Evaluation

When the paint or ink is dry, you may wish to extend this activity into a creative writing assignment. Have students reclaim their "river system" maps, and label them with the names of rivers, towns, and cities. Encourage students to show where mountains or hills might be located around the watershed boundaries and label them accordingly.

Encourage students to write a story or travel piece about their river system. Have them pretend they are trying to encourage people to come and visit the area. Below are some questions they might want to ask to get themselves started.

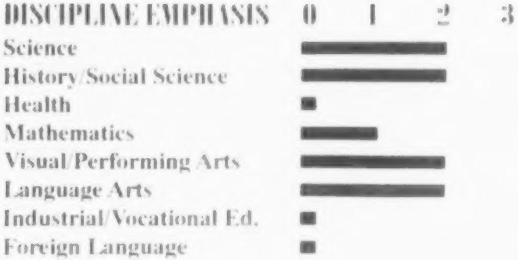
- What do the natural areas within the watershed look like? These could include forests, lakes, streams, marshes, or valleys.
- What animals and plants live in the watershed?
- What is the history of the towns and cities in the watershed? Who settled there and why? (Encourage students to use their imaginations.)
- How do people use the river today? Include recreational and commercial uses.

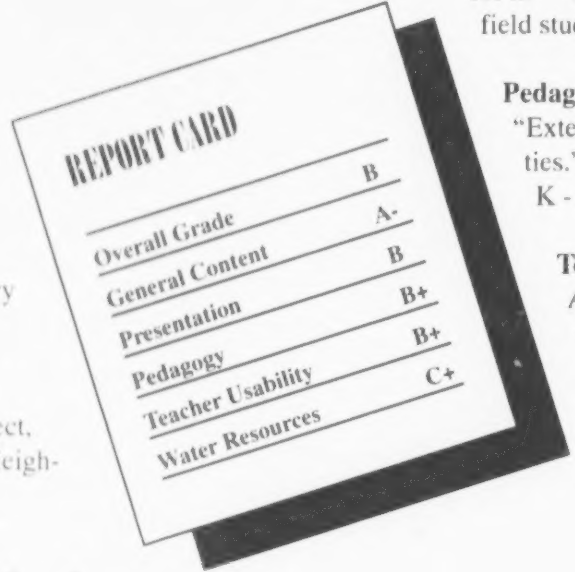
The Streamside Community

Adopt-A-Watershed
PO Box 356
Hayfork, California 96041
(916) 628-5334

$40.00. 1992. 71 pages.

"The Streamside Community" focuses on riparian (streamside) plants and animals as a method to reinforce the concept of community and theme of systems and interaction. During a field trip to the students' adopted watershed, an inventory of plants is taken for the purpose of studying plant adaptations. The program culminates with an amphibian population study and restoration project, summarized and presented within a Neighborhood Theater activity.





REPORT CARD	
Overall Grade	B
General Content	A-
Presentation	B
Pedagogy	B+
Teacher Usability	B+
Water Resources	C+

COMMENTS

General Content

"This curriculum focuses on the riparian ecosystem and how to care for it." "It is a well-done curriculum for its intent as a long-term field study and restoration project."

Pedagogy

"Extensive activities involve streamside - watershed communities." "There may be difficulty applying the curriculum at the K - 3 levels."

Teacher Usability

Access to a riparian community is key to the success of this curriculum. "Most schools would have difficulty securing funds for transportation, etc. to participate in the field trips [if not adjacent to the school site]." "The extensive resource guide is helpful; the lessons are well organized."

Specific Content on Water Resources

Deals primarily with the biotic nature of riparian communities rather than water resources *per se*.

Lesson 13 The Streamside Community

AMPHIBIAN POPULATION STUDY AND RESTORATION PROJECT

Focus: Students go on a field trip to begin a long-term amphibian population study and to restore part of the riparian area to enhance its ability to support amphibian populations.

Overview

In this lesson students will begin a study of populations of amphibians in the adopted watershed. This study will be continued in later years to compare data in order to see fluctuations in the populations. Students will also work to improve the environmental conditions for amphibian populations.

Background Information

mphibian populations around the world re thought to be declining. Data is being gathered and compared worldwide to see if a decline in amphibian populations is observed. The data gathered by students doing this study and studies like it in other watersheds may be used in the future to help scientists recognize changes in local amphibian populations. Although the data from this one study cannot determine how the entire population in the region is doing, data gathered from watersheds throughout the region through the Adopt-A-Watershed program may be quite significant. By sampling small parts of the population one can extrapolate how the population in the whole region is doing. The article *What's Happening to the Amphibians?*, included with the unit, provides further information on possible worldwide amphibian population declines.

Continued at end of lesson

Vocabulary

amphibian: cold-blooded, smooth-skinned vertebrate of the class Amphibia

Materials

Per Class:
- film and film developing envelope
- camera
- yellow flag stakes to mark photo sites (2)
- yellow flag stake to mark center of study area (1)
- permanent marker (1)
- soil thermometer (1)
- soil moisture meter (1)
- air thermometer (1)

TIME

Population study and follow-up activities: about two hours
Restoration work: one hour
This trip should take place during the last two weeks of April.

GROUPING SUGGESTION:

Study groups of 3 to 5 students

CROSS-CURRICULUM CONNECTION:

Math: counting, graphing

PROCESS SKILLS

Communicating
Categorizing
Sorting
Observing
Comparing

Copyright © 1992 Adopt-A-Watershed Program

- **Search the whole area** assigned to their group, turning logs and large rocks, raking leaf litter, and periodically pausing to listen and look for movements of animals.

- **Record each species and each individual found** on the record sheet by writing the name of the species in the species column and making tick marks in the number column for each individual found. Remind students that they do not need to fill in every line. If no amphibians are found, no lines will be filled in.

- **Stress care of the area.** Teach them to return all logs or rocks to their original position. Teach them not to pick flowers or plants. The area will be used for the same study in years to come, so it is important to leave it as undisturbed as possible.

- **As frogs and toads are collected, they should be placed in a can or bucket to be released after the study is completed.** This is to ensure that the same animal is not counted twice. Frogs and toads should be released after the count in the areas where they were found. Salamanders can be released immediately back to the location where they were found.

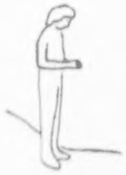
Have students work in their groups to complete the Amphibian *Population Study Results* sheet. The teacher may want to make copies to place into each student's unit folder.

10. Gather back together as a large group. Generate a discussion about the amphibian study. Questions might include:

- We found the greatest number of which species?
- We found the smallest number of which species?
- Why might we have seen many of one species and few of another?
- Might there have been a better time to see more amphibians of certain species (different time of day, different time of year, different weather)?
- Is this riparian habitat healthy for the amphibians, or has it been disturbed?
- How could the habitat be improved?

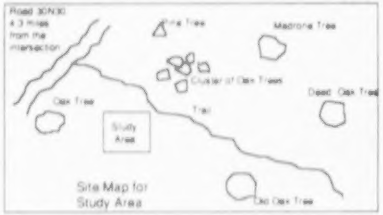
11. **Complete the Amphibian Population Study Class Data Sheet.** The following instructions should help:

- For the question "Which way is the hill facing?," record which direction the slope that the study area is on is facing. If you cannot tell the direction, take a compass and hold it pointing away from your body. Then position your body so that you are facing away from the hill, or in the direction the hillside is facing (see drawing). Turn the dial on the compass so that the orienting arrow is underneath the magnetic, north arrow. Read the direction marked by the pointer at the top of the compass while in this position.



- **Measure the soil and air temperature and soil moisture** in the shade near the center of the study area, as described in step 7.

- **Draw a site location map** on the class data sheet, showing prominent landmarks, the location of the study site, and the location of the photo station (see example). This map will be kept in the permanent Adopt-A-Watershed file.



- **Collect the results from each group** and record the species and numbers found of each.

- **Take a picture from the permanent photo station of the entire class, helpers, teacher, and sign.** Mark the photo location on the map and on a yellow flag stake labeled with "photo station" with a permanent marker. After being developed, this picture will be attached to the class data sheet and placed into the permanent Adopt-A-Watershed file.

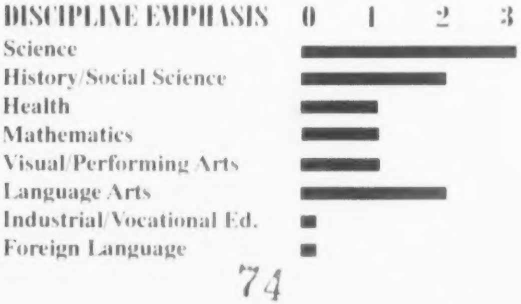
Copyright © 1992 Adopt-A-Watershed Program

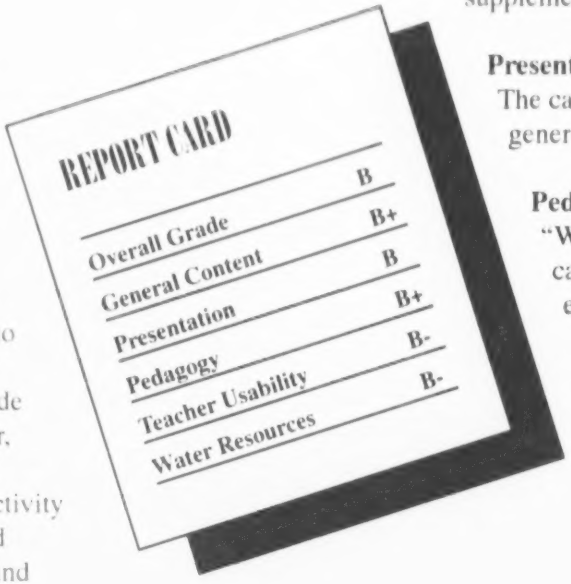
The Green Box

Developed by Humboldt County
Office of Education
Available for purchase from the
California Department of Education
Bureau of Publications, Sales Unit
P.O. Box 271
Sacramento, California 95812-0271
(800) 995-4099

$95.00. 1989. 1 box.

"The Green Box" is a collection of over 200 activity cards arranged in a sequence from exploration (the DO cards) to thought (the THINK cards) to demonstration of knowledge or skills (the SHOW cards). Topic areas include people, senses, technology, energy, air, water, land, the world, global games, change, use, and adaptation. Water activity cards focus on water conservation and consumption, pollution, watersheds, and erosion.





REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	B-
Water Resources	B-

COMMENTS

General Content
"Lots of good activity ideas to be used in variety of ways." "A great supplemental curriculum for independent students."

Presentation
The cards feature engaging graphics, cartoon illustrations, and generous use of color.

Pedagogy
"While creative, there is little connection between activity cards." Observation skills and cooperative learning are emphasized.

Teacher Usability
"The 'Green Box' is a wonderful program, but without an inservice, teachers may not take the time to study its use." "Younger students may have difficulty using the curriculum independently."

Specific Content on Water Resources
"A small section of the cards pertains to water resources. As such, the materials may serve as a supplement in a water resources unit."

WONDERFUL WATER

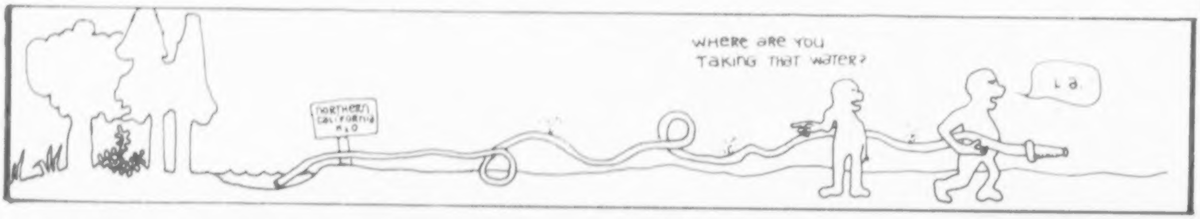
On your school grounds, or close by, find where the most plants are. Observe the area to see whether the number is related to the amount of water they receive. Can you find a place where there are few or no plants because they have no water, or because it runs off or dries up too fast? Can you find a place where there are many plants because there is plenty of water for them? Find out if they get their water naturally or if it is brought to them by a person who takes care of them. Does it come through a hose? Decide how a hose is like an aqueduct (see a dictionary). Compare the way plants depend on water from a hose to the way people in many places depend on an aqueduct. Explain or show your comparison. Also show how groups of people in a town, valley or region are similar to the groups of plants. Make a list showing the ways activities of people are handicapped by shortages of water and improved by plentiful supplies.

MOVING AND MANIPULATING H_2O

Build a model of the watershed in which you live. Mix up some modeling material and construct your model on a sheet of plywood. Work with a six-pack to share ideas and research:

Find out what a watershed is.
Find out the boundaries of the watershed in which you live.
Learn how to show elevations.
Plan how to show the watershed so others will get a clear idea of its size, shape, etc.
Find out whether it has enough water flow to support the people who live in its boundaries.
Be able to tell what happens to extra water that isn't needed.
OR, be able to show how additional water is brought in and where it comes from.
Find out how an aqueduct or pipeline becomes an extension of a watershed and build major aqueducts or pipeline routes on your model.

As you share the results of your research and construction with the class, evaluate the choice made by the first people to settle your area in terms of quantity and quality of water for themselves and for those who live there now.

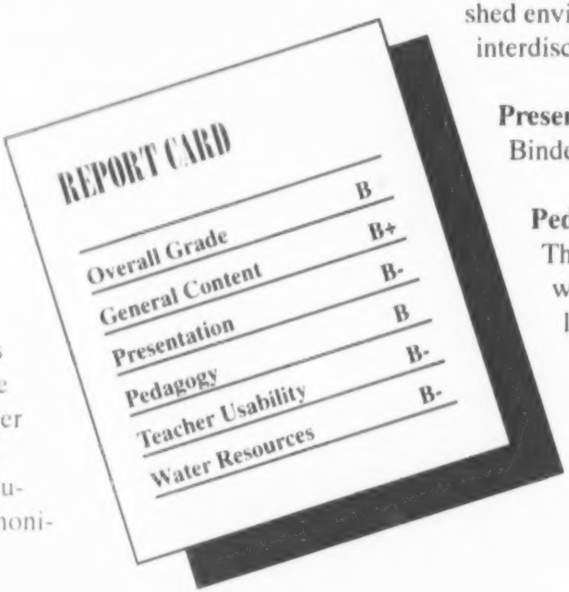

NORTHERN CALIFORNIA H2O
WHERE ARE YOU TAKING THAT WATER?
L.A.

Hands On Save Our Streams

Save Our Streams
The Izaak Walton League of America, Inc.
707 Conservation Lane
Gaithersburg, MD 20878
(800) 284-4952

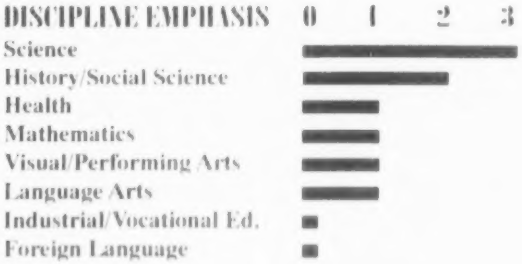
$18.00. 1995. 201 pages.

This teacher's manual is based on the grassroots river and stream protection program of the Izaak Walton League of America. Classroom activities integrate science, social science, language arts, and mathematics to introduce the concepts of watershed, the hydrologic cycle, the relationship between land use and water quality, and water quality monitoring. Field trips provide opportunities for students to apply skills in water quality monitoring and restoration activities.



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B-
Pedagogy	B
Teacher Usability	B-
Water Resources	B-



COMMENTS

General Content

"Well written activities based on observations of stream and watershed environments." "Lessons are written for K - 12 using an interdisciplinary approach."

Presentation

Binder format.

Pedagogy

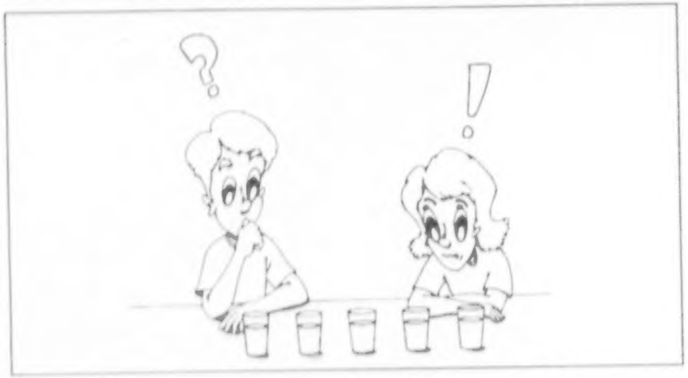
This curriculum covers broad grade levels in each lesson with little suggestion on how to adapt to a specific grade level. Discussions are woven together with demonstrations.

Teacher Usability

The glossary is extremely helpful. Vocabulary may be overloaded for K - 3 use. "Need to have a visible watershed to effectively use this curriculum."

Specific Content on Water Resources

The focus of "Hands On Save Our Streams" is on watersheds and stream environments; pollution and the water cycle are also covered.



Classroom Activity #1

Can You See Water Pollution? **Lesson Time:** 15 minutes

Objective: Students will discuss water pollution and how to tell if water is polluted. Students will determine if they can detect water pollution just by looking at the water.

Key Words:
Bacteria
Chlorine
Water pollution
Bottled water
Suspended solids

Materials:
Five clear glasses
Sample of stream water (taken within the last 24 hours)
Rubbing (isopropyl) alcohol
Food coloring
Tap water
Bottled water
Masking tape or labels to label glasses A,B,C, D and E

Procedure: 1) Before students enter the classroom, prepare five glasses of water samples and label each glass with a letter. Put tap water in glass A. In glass B, put bottled spring water. In glass C, put tap water with several drops of food coloring (enough to distinctly color the water). In glass D, put water with one capful of rubbing alcohol. In glass E, put stream water.

2) Ask three student volunteers to look at the glasses and decide which ones contain polluted water. Students can work as teams, or this can be done as a demonstration for

the entire class. Students should use their senses of smell and sight. Have the students record their observations for each glass. Ask the students to say why they believe certain glasses are polluted and others are not, then discuss the correct answers.

Glass with tap water: This water is polluted because tap water contains chlorine. Although people need chlorine in tap water to kill bacteria and other microorganisms that are harmful to people, chlorine is extremely toxic to fish and other aquatic life, even below detectable levels.

Glass with bottled water: This water may be able to support aquatic life. Because it is natural and has not been treated with chemicals to make it fit for consumption by people, it probably is not polluted. However, you should look on the side of the container to see if you can locate an expiration date. If the expiration date has passed the bottled water may have become contaminated while in storage.

Glass with food coloring: This water obviously looks polluted because it is discolored. Streams with unusual colors in the water often have a serious pollution problem. Although the EPA does not classify color as a pollutant, color pollutes water by blocking light to underwater plants, preventing photosynthesis, during which plants make oxygen critical to aquatic life.

Glass with rubbing alcohol: This water looks clean but smells terrible. This water obviously is polluted even though it looks perfectly clear. This sample reminds students that their sense of smell often is very important in determining if a stream is polluted. Streams may look clean but smell like sewage or other pollutants.

Glass with stream water: This water may or may not be polluted. If it is very muddy or dark, it probably has too many suspended solids or too much sediment for aquatic life to survive. If the water is milky or discolored, tests will need to be done to determine if pollution is present. You cannot tell just by looking.

Grade Breakdown: all grades

Refer to Chapter Four for more information about clean water regulations.

Skills Learned:
analysis
communication
discussion
identification
interpretation
observation
recognition

Extension Activities: See Chapter Three

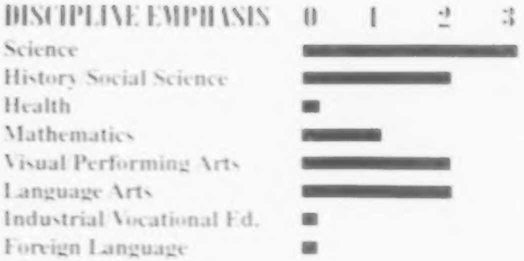
What Is a Watershed?

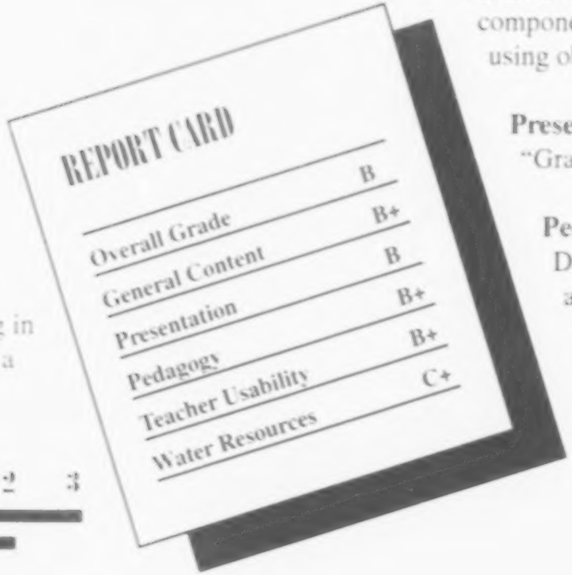
Adopt-A-Watershed
P.O. Box 356
Hayfork, California 96041
(916) 628-5334

🌧 🌧 🌧

$28.00. 1992. 51 pages.

This curriculum uses the concept of watershed as the foundation for learning. Classroom and field activities expose students to both the living and non-living components within a watershed and the changes which occur over time. The program culminates with tree planting in an adopted watershed and creation of a class field book.





REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	B+
Water Resources	C+

COMMENTS

General Content
"Designed for the kindergarten level, this well organized curriculum offers a thorough background section, strong community action component, and field studies." "A nice, concise unit on watershed using observation and classification skills."

Presentation
"Graphics could be improved."

Pedagogy
Discussions and art activities are the focus of most lessons, although outdoor, hands-on activities are also suggested. "Some may be too advanced for the intended grade level."

Teacher Usability
This curriculum works best where a visible and accessible watershed exists.

Specific Content on Water Resources
Strong emphasis on exploring the concept of watershed and assuming the role of land steward.

81

82

Lesson 7 What is a Watershed?

THE FIELD TRIP A-PLANTING WE WILL GO

Focus: Students plant trees to begin the long-term tree succession field study and restoration project.

Overview

Students go on a field trip to their adopted watershed to begin the tree succession study/restoration project. The field trip ties in previous activities which prepared students for work in the field.

Two options for buddies are available for this field trip. Teachers may choose to use **intermediate** students for buddies or **high school** students. If you choose to use intermediate buddies, students will complete **Part I** and **Part III** of the lesson only. Buddies will assist younger students in planting trees, taking measurements, and making pictorial and written descriptions for use in later years. If you have chosen high school buddies, students will complete **Parts I, II and III. Part II** includes collection of the succession study data which will be used to compare to data collected in later years as well as data collected from different study sites.

Whether you are using intermediate or high school buddies for this project, it is important to keep in mind that the data collected will be compared not only to data collected on the same site in successive years, but also to data collected from other sites. Information such as soil temperature, soil moisture, soil type, pH, plant succession, etc., may vary from site to site. See that the data sheets are completed as thoroughly as possible. Careful attention to description and technical information will greatly enhance your students' abilities to draw conclusions and make comparisons in succeeding years.

Background Information

In *The Earth Manual* by Malcolm Margolin read Chapter 9, "Planting Trees." Look specifically at page 158, the speech to students before the field trip, "the craziest speech they ever heard."

Succession is the process by which an area goes through a series of changes leading to its climax form, determined by a number of environmental factors, after being damaged or altered by some external pressure or event. The study of plant and animal succession is a broad field within the environmental sciences and much too complex to be described authoritatively here. What follows is an extremely simplified description. The curious teacher is referred to any good biological text for a fuller treatment of the subject.

The key to understanding succession is to understand the concept of a "climax habitat". Put simply, a climax habitat is the most complex system that the given site is capable of supporting, based upon a number of interrelated environmental factors (temperature, climate, slope, aspect, soil type, underlying rock strata.

Continued at end of unit

TIME:

Possible half day, but 5 hours recommended
Suggest extension of typical kindergarten day by 2 hours

GROUPING SUGGESTIONS:

Part I: Buddy pairs or one older student for each 2 kindergartners. One adult helper for each 5 or 6 student groups.
Part II: Two buddy pairs join together as one group.

CROSS-CURRICULUM CONNECTIONS:

Mathematics
Social studies
Physical education
Language arts
Art

PROCESS SKILLS:

Observing
Communicating
Comparing
Describing

Copyright © 1992 Adopt-A-Watershed Program

Lesson 2 What is a Watershed?

WHAT IS A WATERSHED?

Focus: Students are introduced to watersheds through a brainstorming activity designed to elicit their current knowledge and assumptions about what a watershed might be.

Overview

Building on prior knowledge, students can begin to see what makes up a watershed. The definition of and understanding of watersheds will be further developed in the next lesson through hands-on work with models.

Background Information

See *Background Information* for the unit.

Vocabulary

watershed: the land area that drains water into a river system or other body of water.

Materials

pens
chart paper
drawing paper
crayons

Advance Preparation

Prior to the lesson, choose a place on the school playground or campus where the students can observe things in a watershed such as trees, mountains, plants, etc. Remember, unless you are standing on the ocean, you are in a watershed!

Setting the Stage

1. With your students on the carpet or group time area, have the students tell you what they think a "watershed" is. Record all of their responses pictorially.

2. Have the students tell you what they think they might find in a watershed. Record all responses pictorially.

TIME:

30-minute class period

GROUPING SUGGESTIONS:

Whole class

CROSS-CURRICULUM CONNECTIONS:

Art
Language arts
Literature

PROCESS SKILLS:

Observing
Communicating

Copyright © 1992 Adopt-A-Watershed Program

BEST COPY AVAILABLE

Water Cycle, the Earth's Gift

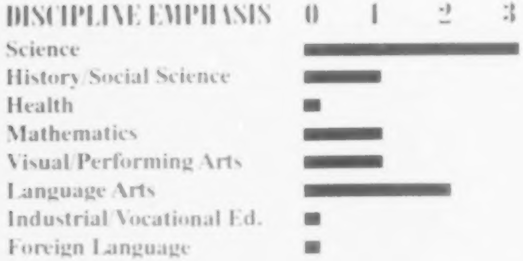
Math/Science Nucleus
4009 Pestana Place
Fremont, California 94538
(510) 490-6284

$19.95. 1992. 273 pages.

"Water Cycle, the Earth's Gift" offers lesson plans and activities related to water, oceans, atmosphere, and weather. The "cookbook" format outlines twelve activities centered around four labs for a four-week unit per grade level, K - 6. Background information and reproducible worksheets are provided in a spiral-bound format.

REPORT CARD

Overall Grade	B-
General Content	B+
Presentation	B-
Pedagogy	B-
Teacher Usability	B
Water Resources	B-



COMMENTS

General Content

"'Water Cycle' covers a good amount of material at each grade level within a four week unit." "It spirals, building upon knowledge gained in previous years."

Pedagogy

"Few opportunities for the students to actually discover their own meaning." "Heavy emphasis on filling in blackline masters." "Some lessons seem too abstract for primary grades."

Teacher Usability

Extensive teacher background sections and a resource section are provided. "The curriculum requires literature and materials for each grade level."

Specific Content on Water Resources

While not an environmental education-based curriculum, "Water Cycle" teaches the properties of water, atmosphere and weather, the water cycle, and water distribution patterns.

85

86

WATER CYCLE - WEATHER (K)

DURING LAB

OBJECTIVES:

1. Observing wind.
2. Determining the direction of wind.

VOCABULARY:

anemometer
wind vane
wind

PROCEDURE:

MATERIALS: *Feel the Wind* by A. Dorros use module WATER CYCLE - WEATHER (K), soapy water, straws, anemometer and wind vane (see MATERIALS TO MAKE)

Wind can be defined as "moving air." Windmills can be used for things like generating electricity or grinding grain or pumping water, and sails push sailboats and windsurfers. The main reason we study winds is because of their importance in weather. Prevailing winds from the sea, like monsoons, carry rain, and winds from the desert bring heat. Strong winds can cause a lot of damage. Large cyclonic storms are called hurricanes in the Atlantic, typhoons in the Pacific, cyclones around India and willy-willies in Australia.

Winds are normally described by speed and direction. Wind speed may be described in miles per hour, which is measured with an anemometer. Wind causes the arms to rotate, and their speed can be measured.

Ancient people had many beliefs about the winds. The ancient Greeks thought that the winds were the children of the sky and the earth. Unfortunately, the winds were very unruly, so Zeus decided that they needed a dependable guardian. He chose Aeolus, who kept them in a hollow cliff far out to sea. When one of the gods called for a wind, Aeolus would punch a hole in the cliff wall with his spear. Then he plugged up the hole until it was time for the wind to return. The North Wind was ice and wild. The South Wind dripped water from his beard, and would spread fogs that the sailors would get lost in Zephyr, the West Wind. Zephyr was gentle wind. He would clear the sky of clouds and give beautiful weather.

Let the students help you define wind when you introduce the subject. Go over the uses of wind, by showing pertinent pictures. Describe wind storms and show pictures. Discuss how to measure wind, from find the direction by wetting a finger and holding it up, to watching a kite, pinwheel or bubbles. You may want to read *Feel the Wind*.

Go outside with students and find the wind direction with the students by using their fingers, with a wind vane, with bubbles, and with pinwheels. Most students are not aware how to find out where the wind is coming from. The name of the wind refers to the direction its coming from. A west wind moves west to east. If you have an anemometer show the students how it works. Students can make bubbles by using a straw and put a little soapy water and blow softly. (You may want to do this exercise after milk time, and have the students save their straws.) Have the students observe which way the bubbles go. Discuss their results especially if all the wind direction indicators agreed.

WATER CYCLE - ATMOSPHERE (K)

POST LAB

OBJECTIVES:

1. Exploring how clouds are formed.
2. Demonstrating how clouds are formed in the atmosphere.

VOCABULARY:

atmosphere
clouds

PROCEDURE:

MATERIALS: jar, dish or margarine that fits on top of jar, hot water, ice, refresher (spray)

Clouds may be very mysterious to children. In this demonstration you will illustrate the major components of cloud formation.

You can make a cloud by following the instructions below. Describe each ingredient as you go. Let them know that the cloud is sometimes hard to see (but having students seeing you make a cloud will help them remember how clouds are formed.)

a) Boil water. Fill a jar with one third hot water.

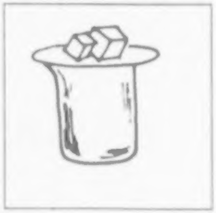
b) Tell students that the steam represents the water rising from lakes and oceans. Tell them that the ocean is not hot, we are just speeding up the process. This is an experiment.

c) Spray a little refresher into the jar. This represents the dust in the air. Cloud droplets form around particles.

d) Put a dish or margarine tub on top of the jar and put ice in it. See diagram for set up. This represent the cooling high up in the air.

e) You will see some faint swirling of the steam inside the jar. Have the students look closely at the clouds.

Once you get the feel for making clouds, make a few stations for the students to observe the clouds. Refer to this experiment as a cloud in a bottle. Tell students if they want to make a cloud at home, they must tell their parents to help.

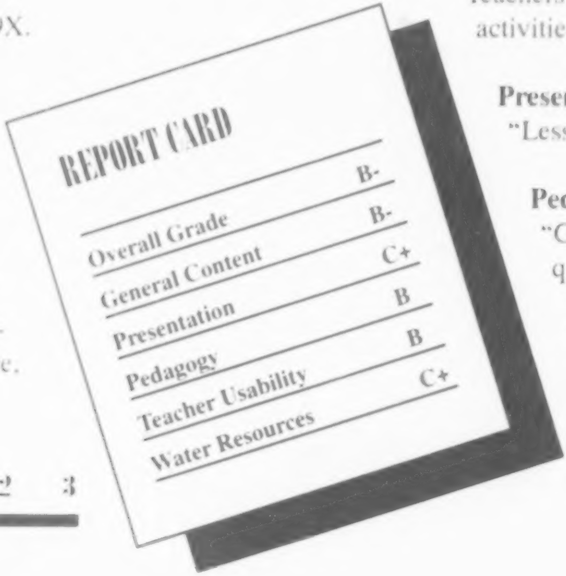


Water, Stones, and Fossil Bones

National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3000
(800) 722-6782

$18.50. 1991. 140 pages. Item PB089X.

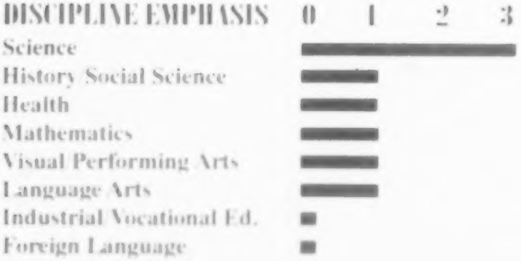
"Water, Stones, and Fossil Bones" is designed to integrate earth science concepts into the teaching of elementary science. Activities begin with a focus on a particular concept and a challenge in the form of a question or problem. Hands-on procedures and further challenges enable students to explore space, land, water, air, and the earth's past.



REPORT CARD

Overall Grade	B-
General Content	B-
Presentation	C+
Pedagogy	B
Teacher Usability	B
Water Resources	C+

DISCIPLINE EMPHASIS



COMMENTS

General Content

"This is a compilation of favorite lessons from National Science Teachers Association (NSTA) educators." "Several excellent activities begin the discovery and investigation process."

Presentation

"Lessons do not appear to flow together."

Pedagogy

"Good hands-on activities and demonstrations; open-ended questioning strategies."

Teacher Usability

Most of the water-oriented activities are appropriate for grades 3 and up.

Specific Content on Water Resources

"Water is one of six parts and it is not presented within the context of environmental education." Material does cover groundwater, water quality, and water pollution.

24 Fred the Fish

An Interdisciplinary Water Pollution Activity

BY PATRICIA A. CHILTON-STRINGHAM AND JANET WOLANIN

Materials and Equipment:

The whole class will need:
Script pages
A pair of scissors
9 large index cards
A glue stick or some tape
A light colored sponge
A yarn needle
A small weight (metal nut)
String
A wide-mouthed jar or large beaker
Cold tap water
A pencil
5 small paper cups (or baby food jars)
Soil
Brown sugar (fertilizer)
Pancake syrup or molasses (oil)
Salt
Punched paper dots (litter)
A medium beaker or glass jar
Detergent
Warm tap water
Red food coloring (sewage)
Green food coloring (toxic waste)

Focus:

Without water, life would be impossible. We use it in many ways—for drinking, bathing, recreation, farming, and manufacturing. We depend on a continuous supply of clean water, yet each time we use it we change it—sometimes by polluting it.

Challenge:

In what ways do we pollute water? How can we clean the water we pollute? How can we prevent water pollution?

Time: One to four 30-45 minute class periods.

Procedure:

1. Copy and cut apart the nine roles from the script at the end of this activity, and attach them to the large index cards with tape or glue.

2. Cut a fish shape out of the sponge. Use the yarn needle to thread a string through the bottom of the fish, and then attach the weight so it hangs below the fish.

3. Fill the large glass jar or beaker two-thirds full with cold tap water. Thread another string through the top of the fish, and suspend it in the water by tying it to a pencil positioned across the mouth of the jar. Adjust the length of the string until the fish is suspended midway in the jar of water (see the figure).

4. Number the paper cups or baby food jars 1 through 5, then place soil in cup 1, brown sugar (fertilizer) in cup 2, pancake syrup (oil) in cup 3, salt in cup 4, and paper dots (litter) in cup 5. Pour detergent and warm water into the medium-sized jar, and set out red and green food coloring (sewage and toxic waste).

5. Next, introduce Fred the Fish to the class. Tell them that he has grown up in a protected stream in a nature preserve, but has now decided to leave the preserve and journey downstream. The class has been invited to share in his adventure.

6. Distribute the script cards, cups, food coloring, and jar of warm soapy water to 17 volunteers. Ask all the students in the class to number their papers from 1 to 9. As the students with script cards read them, those with the appropriate ingredients should dump them into Fred's jar. [illegible] should write down [illegible] each time they are asked the question, "How is Fred?"

7. After all the ingredients have been dumped in, lift Fred out of the jar, and discuss the change in his appearance and that of the water. (Someone will probably remark that Fred looks dead.)

8. Ask students to compare their lists of adjectives, and then draw cartoons depicting Fred's adventure. (See the example at the end of this activity.)

9. Do not dump the contents of the large jar down the sink. Instead, pour the contents through a strainer over a large, grassy area where natural filtration can take place. Throw away the paper dots strained from the water.

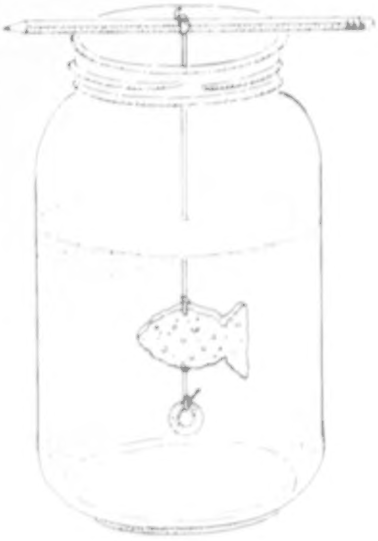
Q What are some ways to dispose of Fred's polluted water? What are the environmental consequences of each alternative? (Where does water go when it is flushed down the toilet? Poured down the sink?)

Further Challenges:

Find out where the wastewater in your home or school goes. Contact your local health department regarding septic systems or visit a wastewater treatment plant in your community.

References:

Chilton, Patricia. (1979). A fish story. Kalamazoo Soil Conservation District, Kalamazoo, MI.



The Authors

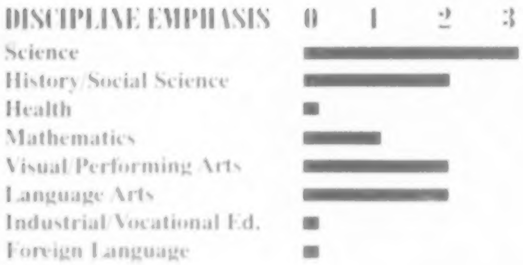
Patricia A. Chilton-Stringham is an environmental educator in Portage, MI. Janet L. Wolanin teaches science at the St. Francis School in Goshen, KY.

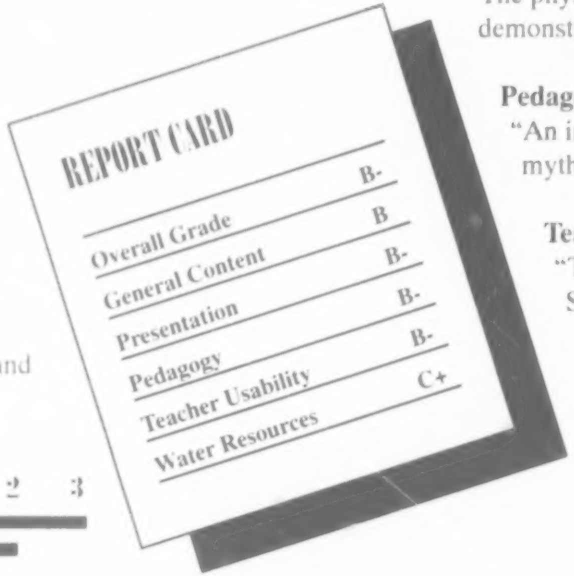
Wet and Wild: The Physical Ocean

USC Sea Grant
Hancock Institute for Marine Studies
University of Southern California
Los Angeles, California 90089-0373
(213) 740-1961

$10.00. 1983. 81 pages. Bilingual.

One of six units, "The Physical Ocean" (Unit 1) explores the physical properties of water within the context of oceanography. The hydrologic cycle, currents, waves, ocean temperature, and climate are investigated through 26 hands-on activities. A supplemental activities and resources section is also included.





REPORT CARD

Overall Grade	B-
General Content	B
Presentation	B-
Pedagogy	B-
Teacher Usability	B-
Water Resources	C+

COMMENTS

General Content

"'Wet and Wild' is primarily an introduction to oceanography."
"The physical ocean is addressed through many good activities and demonstrations."

Pedagogy

"An interesting use of folklore." "Good ties with literature, myths, and legends."

Teacher Usability

"This could be easily integrated with other curricula." Students' proximity to the beach helps the concepts become easily introduced.

Specific Content on Water Resources

"Specifc water resources issues are touched upon, although it is an oceanography unit."

93

94

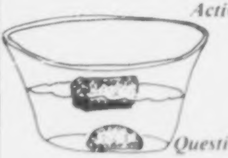
What's so special about water?

Grades K-3

Objective The student will practice the cognitive skills of classification and seriation (dealing with objects in terms of their size, quantity, or quality) as applied to other properties of water.

The student will be able to predict which object will sink or float in water.

Materials Plastic basin with water and numerous small objects—two sizes of each. Shells, rocks, twigs, cotton balls, corks, sponges, etc.



Activity Water buoyancy. (Buoyancy is the quality of being able to support a floating object.) It is important for the teacher to provide the children with criteria for ordering and seriating sizes, shapes, etc. Have the children *predict* which objects they think will sink/float and discuss what is happening with them.

Questions (Before Activity.) *What are the names of these objects? How are they alike? How are they different?* (Put together things that are alike. Put together things that are different. Arrange them by size.) *Which objects do you think will float?* (Make a list.)

Materials Spring scale, twine, rock, bucket(s) of water, materials for charting (paper and pencil).

Activity On a table place a spring scale, rock, twine, and a bucket of water. The students will chart the varying weights of the rock, both in and out of water. Added interest will result with an identical bucket of sea water or salt solution.

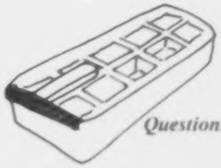
Questions *How much does a rock weigh in salt water? In fresh water?*

Questions (continued) *When does it weigh the least? Most?*

(You may allow the student to predict these outcomes before the activity.)

Materials Squares of wax paper, chipboard, eye dropper, small quantity of water.

Activity Water surface tension. (Water falls in drips because it has high surface tension, meaning its molecules stick strongly together.) Wax paper overlayed on small squares of poster board will provide a suitable surface for experimentation with water surface tension. The student will discover by use of an eye dropper that the drops are rounded and not flat.



Questions *What does a water drop look like? Does it look round or flat? What happens if you add another drop to the first drop? What happens when water droplets are placed on a plate of glass held over printed material?* (Distortion, magnification.)

Materials Hot plate, tea kettle or saucepan, and ice cubes or a means of freezing water (freezer).

Activity Water temperature and states of water. (Few substances other than water exist in nature in all three states: solid, liquid, and gaseous.) Use a hot plate to heat water and ice cubes to chill it to effect temperature change.

Questions *What happens when we put water in the freezer?* (It becomes a solid.) *When we heat water?* (It becomes a gas—steam.) *After boiling the vessel dry, what has happened to the water? Where did it go? How do you explain steam? Which form of water is found in the ocean? What are the three forms of water?*

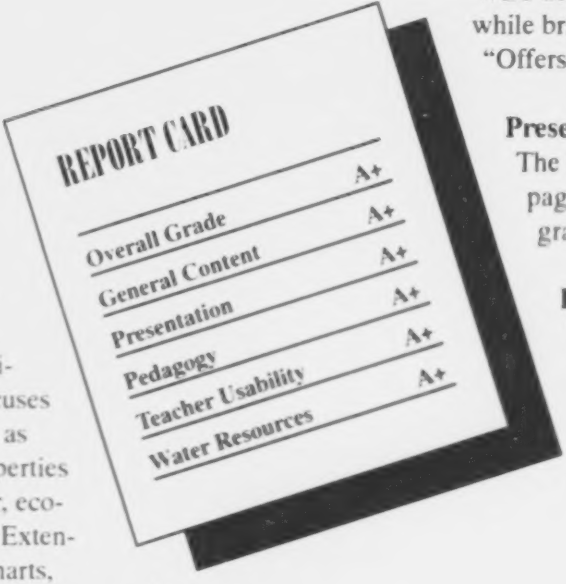
Project WET Curriculum and Activity Guide

The Watercourse and Council for
Environmental Education
c/o Montana State University
201 Culbertson Hall
Bozeman, MT 59717-0570
(406) 994-5392

🌧 🌧 🌧 🌧 🌧

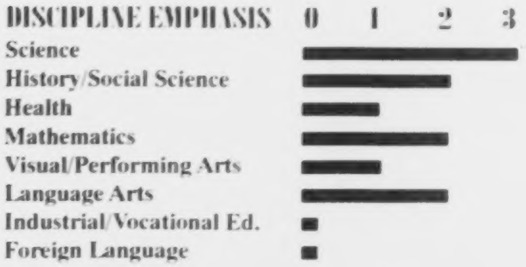
Only available through training workshop. 1995. 516 p.

Project WET is a national water education program designed to promote awareness, appreciation, knowledge, and stewardship of water resources. This guide reflects these goals in a collection of 91 interdisciplinary activities for K - 12. Content focuses on the human relationship with water, as well as the chemical and physical properties of water, quantity and quality of water, ecosystems, and management strategies. Extensive cross-referencing and planning charts, supplemental resource guide, and glossary are provided.



REPORT CARD

Overall Grade	A+
General Content	A+
Presentation	A+
Pedagogy	A+
Teacher Usability	A+
Water Resources	A+



COMMENTS

General Content

"Comprehensive, thorough background information for teachers." "WET addresses water resources from the widest angle possible, while bringing local issues into sharper focus for students." "Offers strong cultural connections."

Presentation

The text is well laid out with clear, reproducible student pages. "Exceptionally well put together" and "augmented by graphics."

Pedagogy

"Objectives are clearly written in behavioral terms." "Activities are flexible and well designed ..." "relevant and meaningful." "Assessment strategies are diverse and tied to each lesson." "A constructivist approach."

Teacher Usability

Extremely teacher-friendly! "Materials are easily obtainable, procedures are clear, and the 'Charting the Course' section is invaluable."

Specific Content on Water Resources

Exceedingly comprehensive coverage.

Aqua Bodies

■ Grade Level:
Lower Elementary, Upper Elementary

■ Subject Areas:
Life Science, Health, Mathematics

■ Duration:
Preparation time
Part I: 15 minutes
Part II: 15 minutes
Part III: 10 minutes
Activity time
Part I: 30 minutes
Part II: 30 minutes
Part III: 30 minutes

■ Setting:
Large, open room

■ Skills:
Organizing information (estimating, calculating, categorizing), Analyzing (comparing, identifying patterns)

■ Charting the Course
This activity is a good introduction to other activities regarding life systems and water. "Aqua Notes" provides further information about how the body uses water. Water-related adaptations are addressed in "Water Address."

■ Vocabulary
body water content

What is the difference between a raisin and a grape? Water!

Objectives

Students will:

- conclude that water is the main ingredient of living organisms.

Materials

- *Dried fruit*
- *Ripe fruit*
- *Balance* (optional)
- *Butcher paper* (about 120 feet [36 m] for a class of 30) or 2–3 sheets of newspaper taped together for each student
- *Chalk* (optional)
- *Crayons*
- *Scissors*
- *Bathroom scale*
- *Containers to hold water* (e.g., gallon jug, buckets, zip-lock bags, balloons)
- 4" x 6" (10 x 15 cm) *index cards*
- *Tape*

Making Connections

People drink water every day, but they rarely think about the proportion of their bodies that is composed of water. Learning how much of their bodies are composed of water encourages students to appreciate life's dependence on water.

Background

Active living organisms are composed of at least 50 percent water. This is true whether they live in a desert (certain cacti have 90 percent water content) or in the oceans (body water content of many whales is 75 percent). Regardless of the environment, organisms are able to acquire and maintain a healthy water balance.

The human body is about 65 to 70 percent water. If humans lose more than 8 percent of their body water, they will die. Where is this water located within the human body? About 67 percent of the water in the body is located within cells; about 25 percent is located between cells; and the rest, about 8 percent, is located in the blood.

Procedure

▼ *Warm Up*

Present students with the following situation: two people are stranded in a desert. One person has a basket of food including canned meats, bread, cake, etc.—enough to last a month. The other has only a one-month's supply of water. Which of the two will survive longer? Compare how long we can go without food (about a month) to how long we can go without water (approximately three days).

Explain that the bodies of most living organisms are at least 50 percent water. Display samples of ripe and dried or wilted fruits and vegetables and compare water content (see table) or weight (e.g., raisin versus grape or plum versus prune). Demonstrate the percentage of the fruit or vegetable that is water by cutting off a representative piece. (For example, carrots are 88 percent water, so cut off about 88 percent of the carrot.) Emphasize that the 88 percent water in the carrot is actually within tissues and cells and therefore did not spill out when the carrot was cut. (This may counter a misconception that water is loosely sloshing throughout the body.) Do students think humans have water in their bodies? Ask students to guess what percentage of their bodies is made up of water.

WATER CONTENT IN SELECTED FOODS

Food	Percent Water
Potato Chips	2
Pizza	49
Ice Cream	61
Beef Liver	70
Bananas	74
Grapes	81
Oranges	87
Carrots	88
Tomatoes	94
Lettuce	96

(Source: Calculated by van der Leeden, Frits, Fred Troise, and David Todd. 1990. *The Water Encyclopedia*. 2nd ed. Chelsea, Mich.: Lewis Publishers, Inc., using weight and water content values provided by Bowes and Church's *Food Values of Portions Commonly Used*. 14th ed. Harper and Row.)

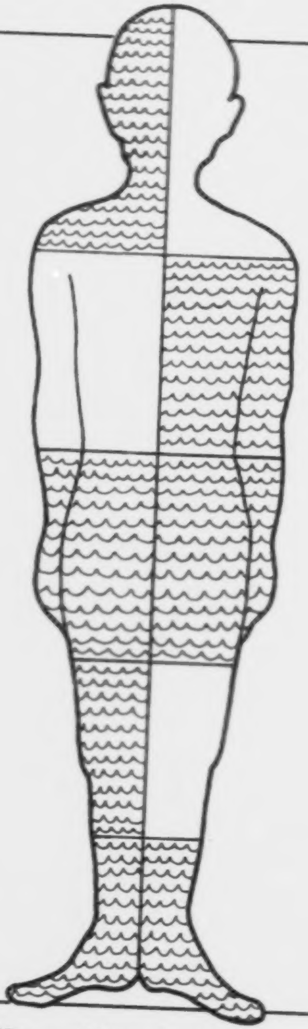
▼ *The Activity*

Part I

NOTE: K–2 teachers may wish to focus on *Part I* only.

1. **Have students work with partners to trace their body shapes onto butcher paper.** An alternative is to have students stand against a wall or lie on the blacktop and trace each other with chalk.

2. **Explain to students that the percentage of water in their bodies is approximately 65-70 percent.** (For this activity, 70 percent [about $^{3}/_{4}$] will be used; the actual amount varies with age and gender. For younger students, demonstrate $^{3}/_{4}$ by showing them a circle, or a block divided into four equal parts, and remove three of the four equal pieces.)

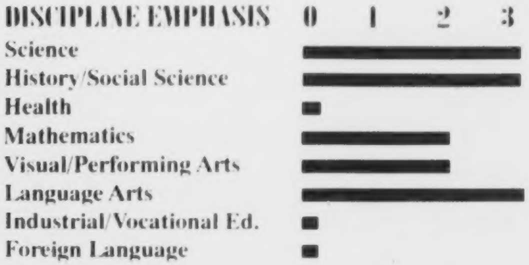


A Child's Place in the Environment: Caring for Aquatic Systems

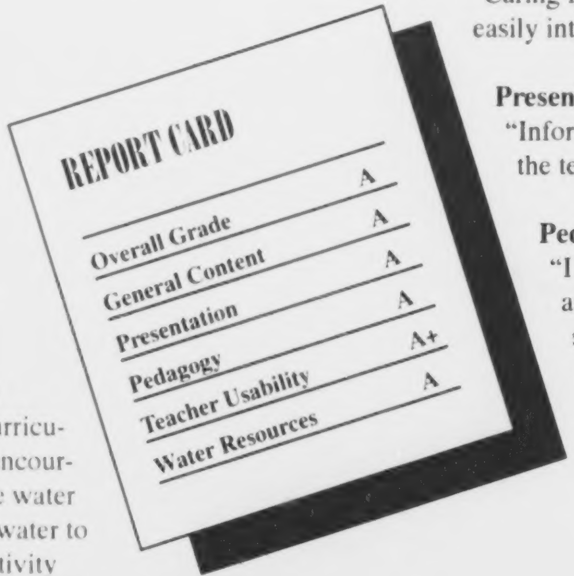
California Department of Education
Bureau of Publications, Sales Unit
P.O. Box 271
Sacramento, California 95812-0271
(800) 995-4099

Attn: Olga Clymire
Lake County Office of Education
1152 South Main Street
Lakeport, California 95453
(707) 263-7249
$43.00. 1994. 412 pages.

"Caring for Aquatic Systems" is the fourth grade unit within *A Child's Place in the Environment* series. Designed as an interdisciplinary and thematic environmental education curriculum, "Caring for Aquatic Systems" encourages students to become aware of the water cycle, understand the importance of water to living things and the ways human activity affects water, and act responsibly toward the environment.



101



REPORT CARD

Overall Grade	A
General Content	A
Presentation	A
Pedagogy	A
Teacher Usability	A+
Water Resources	A

COMMENTS

General Content
"A premier curriculum!" "Content driven and student centered." "'Caring for Aquatic Systems' offers excellent lessons which can be easily integrated into the fourth grade curriculum."

Presentation
"Information is densely packed ... could be overwhelming for the teacher."

Pedagogy
"I liked the use of student journals and performance-based assessment." "Lessons are rich in hands-on activities, simulations, and the arts." Cooperative learning is emphasized throughout.

Teacher Usability
"Offers an outstanding list of resources."

Specific Content on Water Resources
Topics stress water use and conflict in California, stewardship and community action. "Well balanced on the issues."

102

Lesson 18

What Can Students Do to Conserve and Protect Water?

Story Link: In Lesson 17 students studied the ways that John Muir and Marjory Stoneman Douglas attempted to protect specific water systems. In this lesson students will determine how much water they use, develop a conservation plan for their use of water, and identify ways they can reduce the amount of water pollutants generated from their homes.

Subconcept: People can choose to conserve water, maintain or improve its quality, and protect aquatic systems.

Lesson's Concepts:

- Humans need to exercise judgment, care, and planning in their use of natural resources. (*Science Framework*, page 125)
- Humans use oceans and other bodies of water for food, energy, minerals, and medicine and for the disposal of waste. (*Science Framework*, page 105)
- Water is important in our daily lives and is used by humans for many different purposes.
- The most responsible action that individuals, families, and society can take is to conserve water and, thus, to increase its availability.
- Keeping water from becoming polluted and conserving water are ethical and practical concerns involving public policy and individual responsibility. (*Science Framework*, page 97)

Overview: Students identify changes they can make in their lives that would have a positive effect on aquatic ecosystems. Groups rank water use based on the amount of water needed. Groups identify and explain which water uses they can give up for a specific amount

---

Transparency

GROUP RANKINGS OF WATER USAGE

Type of water use	Rankings of use from most to least amount (1–12), by group number							
	1	2	3	4	5	6	7	8
1. Drinking								
2. Showering								
3. Bathing								
4. Flushing toilet								
5. Brushing teeth								
6. Washing dishes by hand								
7. Using an automatic dishwasher								
8. Washing clothes								
9. Watering lawns, other plants								
10. Cooking or preparing food								
11. Playing								
12. Cleaning or washing things								

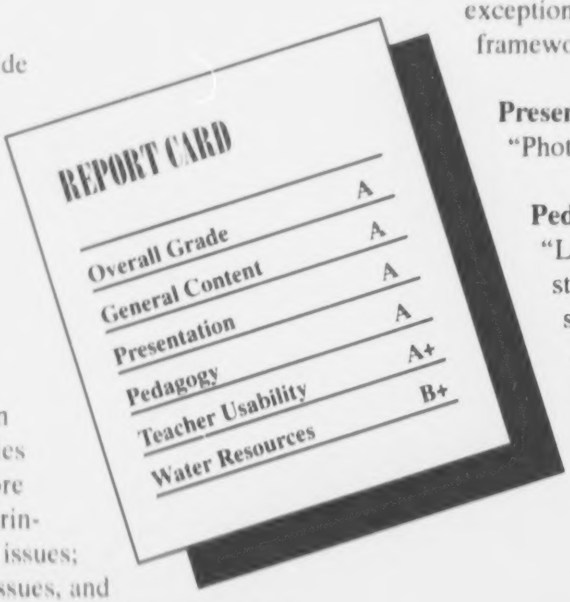
GRADES 4-6

Aquatic Project WILD

Council for Environmental Education
Distributed in California by:
California Department of
Fish and Game
1416 Ninth Street
Sacramento, California 95814
(916) 653-3857; (301) 493-5447 outside California

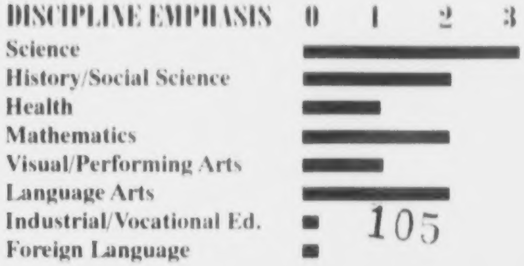
No charge for book (provided at fee-based workshop). Attendance at a Project WILD workshop is a prerequisite for the Aquatic Project WILD workshop. 1995. 242 pages.

Recently revised, "Aquatic Project WILD" is an interdisciplinary and supplementary program based upon an exploration of water and aquatic species and habitats. Diverse activities explore awareness levels; values; ecological principles; management and conservation issues; people, culture, and wildlife; trends, issues, and consequences; and responsible human actions. Numerous appendices provide cross-referencing by skill, grade-level, and topic.



REPORT CARD

Overall Grade	A
General Content	A
Presentation	A
Pedagogy	A
Teacher Usability	A+
Water Resources	B+



105

COMMENTS

General Content

"This book covers a broad range of water topics, presented as exceptionally well articulated lessons based on a conceptual framework." "Excellent teacher background."

Presentation

"Photographs and illustrations are of a high quality."

Pedagogy

"Lessons provide both extension activities to challenge students as well as variations to suit different learning styles." "Conflict is addressed throughout." "Extensions offer depth and there is an evaluation section at the end of each lesson ... an opportunity for authentic assessment."

Teacher Usability

Easy to use as a supplement. Many cross-referenced indices are helpful, as is the "well done" conceptual framework.

Specific Content on Water Resources

"More emphasis on aquatic biology than water resources and 'the science of water.'"

106

TO DAM OR NOT TO DAM

OBJECTIVE

Students will evaluate potential positive and negative effects from constructing a dam on a river.

METHOD

Students role play individuals representing differing perspectives and concerns related to a complex issue.

BACKGROUND

Hypothetical situation: The town of Rocksburg, population 900, is located along the scenic Jones River approximately 60 miles from the closest big city. The mayor and city council of the big city have proposed that a dam be constructed two miles upriver of Rocksburg. In the Environmental Impact Statement written by the city engineers, the following information was identified.

The dam would meet the area's electrical power demand for ten or more years in the future. It would provide some water for irrigation and would help with flood control problems downriver.

Construction would be of rock-earth fill, 75 feet high and 300 feet across. Seven miles of river would be turned into a lake.

Age: Grades 4-12
Subjects: Social Studies, Science
Skills: analysis, classification, communication, description, discussion, evaluation, generalization, inference, interpretation, invention, kinesthetic concept development, listening, listing, observation, public speaking, reading, synthesis, writing
Duration: two or three 45-minute periods, depending on whether time out of class is used to develop position papers and write essays
Group Size: developed for 30 students; can be modified for smaller or larger groups
Setting: indoors
Conceptual Framework Reference: VI.A., VI.A.2., VI.A.3., VI.A.4., VI.A.5., VI.B., VI.B.1., VI.B.2., VI.B.3., VI.B.4., VI.B.5., VI.B.6., VI.C., VI.C.1., VI.C.2., VI.C.3., VI.C.4., VI.C.6., VI.C.12., VI.C.13., VI.C.15., VI.C.16., VII.A., VII.A.1., VII.A.2., VII.A.3., VII.A.4., VII.B., VII.B.1., VII.B.2., VII.B.3., VII.B.4., VII.B.5., VII.B.6., VII.B.7.
Key Vocabulary: dam, river, costs, benefits, tradeoffs
Appendices: Simulations, Local Resources

The dam construction would take five years to complete and would employ over 2,000 workers. After the dam was finished, approximately 150 workers would be required to keep the plant running.

Wildlife would be affected in the following ways:

- 20% loss to the deer herd that browses the lands alongside the river due to lost forage
- 20% loss to small mammals living in the river valley due to loss of habitat
- 20% loss to the area's songbird population due to lost riverbank nesting sites
- blockage of the upstream and downstream movement of fish that live in the river due to the creation of the lake and dam
- increase of the area's wintering bald eagle population; the dam and lake will increase access to bald eagle prey species, primarily fish; the eagles could winter in the area but would have to migrate to other areas to nest; the dam would reduce riverbank trees suitable for nesting
- reduction and possible elimination of fish species adapted to cooler and/or flowing water including trout, minnows and darters while at the same time increasing warmer, non-flowing water habitat suitable for bass, bluegill and carp
- loss of 10,000 acres of prime timber growing land and wildlife habitat

The people of Rocksburg are concerned about the problems and benefits from the number of people that would come to their town during and after the construction of the dam. For example, they project the arrival of 2,000 workers plus their families during construction for five years and that 150 permanent workers plus their families would stay after the dam was finished. They are concerned about effects on schools, sewage disposal, roads, homesites, property values, and the rural atmosphere, as well as police, fire, and hospital emergency capacities. They see some potential benefits from the development, such as new recreation opportunities for the people of Rocksburg and the city which is only about an hour away (water skiing, sailboarding, motorboating, swimming, fishing,

© 1992 Western Regional Environmental Education Council

A.G. "Rick" Ulture: a representative of the local farmers' coalition interested in the dam's potential for protecting crops from floods as well as its ability to provide water for irrigation.

Lotta Power: a lobbyist for the municipal electrical power company interested in developing the dam.

Rob or Marta Kanu: kayaker concerned with the loss of the whitewater stretch for canoeing and kayaking.

Sam N. Fish: a local sporting goods store owner and avid fisherman concerned with the loss of migration routes of the fish on the river.

Dan D. Lion: the president of the "Save Our Native Plants and Wild Animals" organization.

Pat "Pottery" Brusher: an archeology professor from the local university who has done extensive research on the archeological sites of Indian fishing camps along the river.

Lynn Dripper: the director of the municipal water quality authority responsible for providing quality drinking water for the city, and attracted to the dam's potential for providing a reservoir of high quality water useable during long hot summers.

H. M. Owner: a representative for all homeowners in the river valley below the dam who would like to see more flood control.

Bobbie Lawkeeper: the local Rocksburg sheriff concerned about maintaining police protection, peace, health and safety with only a one-person staff as the sole legal authority in the region.

T. M. Burr: the owner of a lumber company whose land would be inundated by the reservoir.

I. M. Floaten: an owner of a whitewater rafting company who uses the river for commercial rafting. Concerned about loss of the "best seven miles of the river." I.M. argues that the best rapids would be submerged by the lake.

"Sky" Soarer: the president of the local bird club who has organized eagle-watching trips to the river every winter for the last 15 years.

Sam Slalom: an avid water skier who sees the new lake as a real boon to skiing interests.

Velma or Virgil Vigil: a local representative of the Gray Panthers, a group of retired people who are concerned about any rise in power bills.

"Boater" Cartop: an older fisherperson who enjoys throwing the boat on the top of the car and putting in at the closest float spot—especially lakes!

Marshal or May Flyfisher: a long-time resident who champions the purity of fly fishing and insists on pristine habitat, noting the necessity of white water riffles.

Col. "Bull" Winkle: the president of "More Moose Now" who believes that with the lake behind the dam, more moose habitat will be created.

Lap Larson: the president of W.O.W. (Watch Our Waves).

Cy or Sy N. Tist: a respected biologist who is prepared to testify about potential effects on wildlife from the building of the dam.

O. L. Slick: a salesperson for motor boats, water skis and other recreational equipment.

Forest or Park Site: a trained forester who has worked in the woods in the area for more than 50 years.

Running Waters: a tribal leader who is concerned about loss of native heritage from flooding the region for the dam.

E. Conomy: a local businessperson who is concerned about the long-range business potential of the area.

C. D. Minium: a wealthy land developer who has architects working on designs for lakeside condominiums and resort homes.

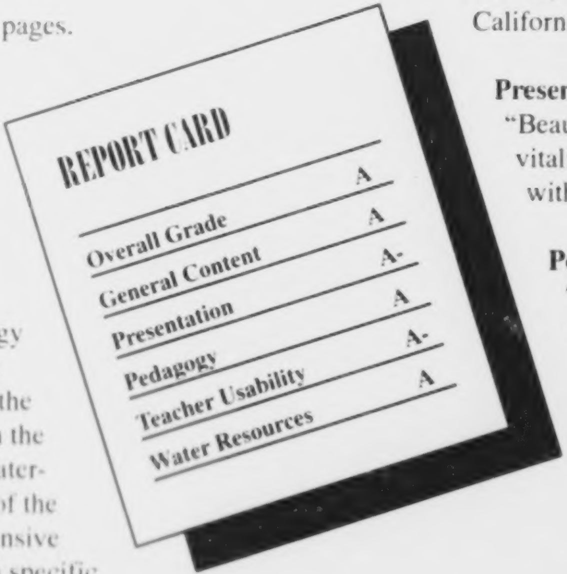
© 1992 Western Regional Environmental Education Council

The Ways of the Watersheds

Frost Valley YMCA
2000 Frost Valley Road
Claryville, New York 12725-9600
(914) 985-2291

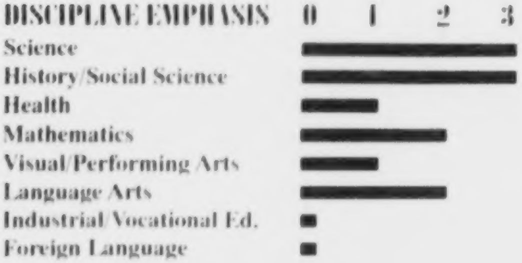
$20.00 and $5.00 shipping. 1995. 248 pages.

"The Ways of the Watersheds, an Educator's Guide to the Environment and Cultural Dynamics of New York City's Water Supplies" examines several aspects of watersheds, associated problems, and solutions. Sections include: The Hydrology of the Watersheds, The Geology of the Watersheds, The Ecology of the Watersheds, The Pollution Sources of the Watersheds, The Development Within the Watersheds, The Technology of the Watersheds, and Conserving the Quantities of the Watersheds. Two appendices and extensive bibliographies are provided. Although specific to New York, activities can be modified to work elsewhere.



REPORT CARD

Overall Grade	A
General Content	A
Presentation	A-
Pedagogy	A
Teacher Usability	A-
Water Resources	A



COMMENTS

General Content

"A very comprehensive study of water." "Although New York focused, it offers many activities which could be integrated into a California curriculum."

Presentation

"Beautifully laid out; colors communicate the purity and vitality of water." "Three cheers - printed on recycled paper with vegetable-based inks!"

Pedagogy

"Excellent role-playing activities on differing points of view about water use." "Critical thinking is encouraged."

Teacher Usability

"Background information is good; effective connections are made between the lesson and the watershed." "Activities may be too informal for classroom use" and 'guideline' answers to discussion questions are not provided."

Specific Content on Water Resources

While somewhat specific to the Catskills, it "addresses water use and conflict inherent in the study of watersheds."

75% of the Earth

Grades: all grade levels
Objective: to illustrate the distribution of water resources on our planet
Subjects: Earth and Life Sciences, Chemistry, Math, Social Studies

Materials: One clear 10 gallon container, 5 gallons of water, three clear 5 gallon containers, one cup, one eyedropper, tablespoons, paper, pencils, calculators (optional)

Information:

"If all existing water could be spread evenly over a smooth sphere the size of the earth, it would cover the globe to a depth of 3,000 meters or almost 2 miles." - *Water: The Threatened Lifeline* by Sidney R. Jumper, Update, Fall 1992, National Geography Society

Water is a precious natural resource to us and probably our most limited one. Although 75% of the earth's surface is water, it is not all available for our use. Water exists throughout the planet in three forms: solid, liquid and vapor. The global distribution of water has been calculated to be:

97.2% = oceans
2% = ice caps and glaciers
.62% = ground water
.009% = freshwater lakes
.008% = inland seas and salt lakes
.001% = atmosphere
.0001% = rivers and streams

The following demonstration is designed to help students visualize the different distributions of water on earth.

Procedures:

1. To help the students visualize the global distribution of water, present a container with 5 gallons of water that represents all of the water on earth. As you talk about the location of water throughout the planet, remove the specified quantities into other containers.

2. 97.2% of all of the water on earth is in the oceans. This water contains dissolved solids, mostly salt. It can be used for transportation, however, it is unfit for drinking, washing, irrigating crops and industrial purposes. When this amount of water is removed from the total in the container, approximately 2 & 1/4 cups of the water remain.

3. Place the 2 & 1/4 cups of water into a smaller container. This amount represents the total amount of fresh water on our planet. A portion of this water is located in glaciers, ice caps, soils and the atmosphere and is thus not directly available for use by humans.

4. Place about 1/2 cup of the fresh water supply into the next container. This is the fresh water available to us though it is not evenly distributed throughout the world. Of this 1/2 cup of available water, we must consider that the water that is found in remote locations, trapped underground or polluted is not available for us to use. The remaining usable fresh water supply is about 5 drops!

5. Place 5 drops of the water into the final container. (Note: A metal pie pan in the bottom of the bucket makes a loud "ting" for a more dramatic effect.) Have the students name all of the ways in our lives today that we use and share these 5 drops of water.

Variations:

- Ask the students to calculate the volume of water for each specific category of global distribution using the percentages given and 10 gallons of water. Provide them with the following quantity: 1 gallon = 320 tablespoons. Examples of calculations would be:

  Total in tablespoons = 10 gallons x 320 tablespoons
  Percentage of oceans in tablespoons = 0.972 x Total in tablespoons

  With each of the calculations, have the students physically measure the amounts of water into different containers. By doing this, they will become even more familiar with the proportions they are computing.

- Using 100 marbles, have the students separate the marbles into piles representing the different water sources.

- As you discuss with your students related water conservation topics, explore the activities from the *Conserving the Quantities of the Watersheds* chapter of this guide.

Watershed Discussion Questions:

- Is water a renewable or non-renewable resource?
- From what type of freshwater supply does your drinking water come?
- How much water do you use every day at home or school?

Source: Adapted from *75% of the Earth Surface* in Linking Your Y with the World and *Info on Water* in Taking the World to Camp

The Water Sourcebook

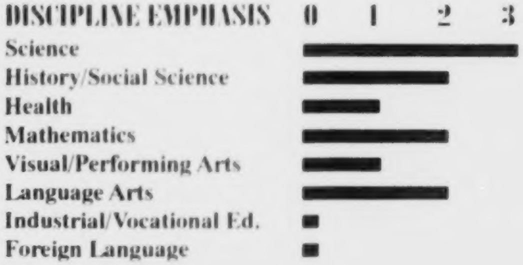
U.S. Environmental Protection Agency
and Tennessee Valley Authority
c/o Georgia Water Wise Council
1033 Franklin Road, Suite 9-187
Marietta, Georgia 30067-8004
(770) 426-8936 x 234

$22.90 inc. shipping (quantity discounts are available). 1994. 532 pages.

This supplemental activity guide offers 61 hands-on water activities designed to support existing curricula. The five chapters cover surface, ground, and wetlands/coastal waters, as well as drinking and waste water treatment. An extensive glossary, curricula/activity correlation index, and 29 teacher fact sheets on such topics as water pollution and surface water quality standards are also provided. This publication (geared specificallly to grades 3 - 5) is the first in a series of four to be released, covering grades K - 12.

REPORT CARD

Overall Grade	A
General Content	A
Presentation	B+
Pedagogy	A-
Teacher Usability	A
Water Resources	A



COMMENTS

General Content
"This very complete curriculum offers hands-on experiences that are unique approaches to explaining difficult concepts." "This curriculum does it all and does it well!"

Presentation
"Clear format and procedures... very attractive." "The easy to read text and handouts are helpful."

Pedagogy
"In-depth coverage of themes; strong, measureable objectives." "Activities are involving; often hands-on and encouraging of high order thinking."

Teacher Usability
"Background information is manageable and the pages are easily reproduced."

Specific Content on Water Resources
"Designed to be used anywhere in the country... excellent discussions on the history of water use and dams." "One of the few curricula that deals with the interplay of coastal waters and the terrestrial environment."

WATER GOES AROUND AND COMES AROUND

OBJECTIVES

The student will do the following:

1. Build a model of a water system from the source to users.
2. Learn to read and interpret a water meter.
3. Plan ways of water conservation at the community level.

SUBJECTS:
Science, Social Studies, Math

TIME:
120 minutes

MATERIALS:
large piece of cardboard
paper towel or bathroom tissue tubes
straws
different sizes of pasta (spaghetti, manicotti, etc.)
glue
paste or glue sticks
small boxes (matchboxes, small milk cartons)
markers
construction paper
student sheets (included)
teacher sheet (included)

BACKGROUND INFORMATION

It has been determined that each person in the United States uses about 150 gallons of water a day. Experts add the number of people who live in a city, town, or community, and multiply that number by 150 to determine how much water is used daily by that community.

People use water for drinking, cooking, bathing, flushing the toilet, laundry, washing cars, and watering lawns. Factories, farms, stores, public utilities, and homes use millions of gallons of water daily. It is a big job for water treatment facilities to supply clean drinkable water to a town, city, or community.

After the water treatment plant cleans the water, it sends it out to the users. As the water travels through a distribution system, it is diverted down different pathways to homes and businesses. The diameter of a pipe determines the quantity of water the pipe can hold and determines the rate the water can travel through the pipe. The volume of water needed for homes or businesses represents a small portion of the volume leaving the water plant. Therefore, smaller pipes are needed near the point of distribution, whereas larger pipes are needed near the treatment plant.

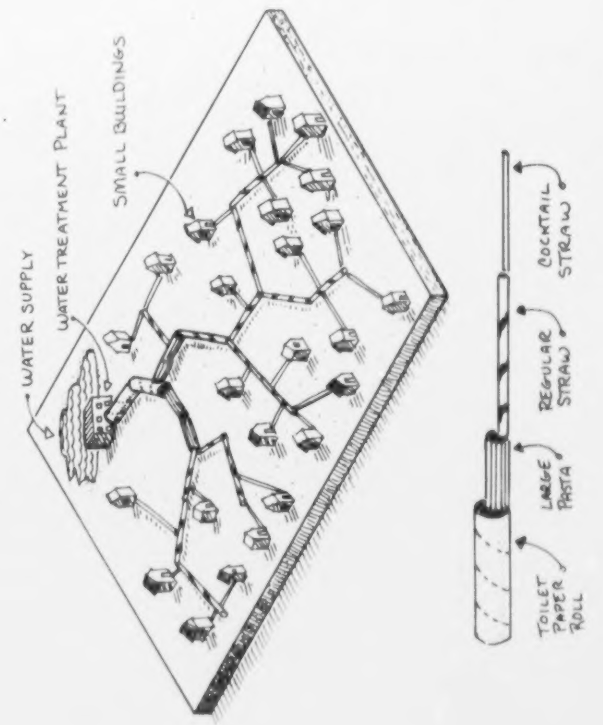
Water treatment plants pump water from a source (lake, river, or groundwater), treat the water, and pump it to holding tanks or water towers. If the water goes to a water tower, it flows by gravitational force from the water tower throughout the distribution system. Otherwise, water distribution is driven by motorized pumps.

Drinkable water is not free. Water treatment facilities and the distribution of drinking water are costly. Customers are charged according to the amount of water they use. A water meter is used to measure how many gallons (liters) or cubic feet (cubic meters) a household or business uses.

Because users pay for water and because there is only so much fresh water available for use, we must conserve our supplies, using them as wisely and efficiently as possible. We must not use water wastefully.

Teacher Sheet

COMMUNITY WATER SUPPLY SYSTEM MODEL



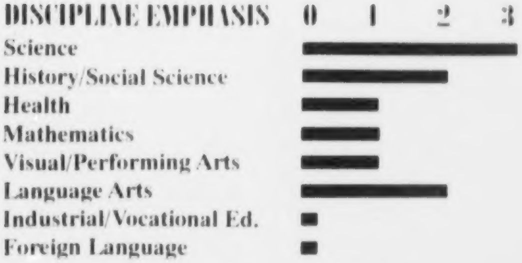
BEST COPY AVAILABLE

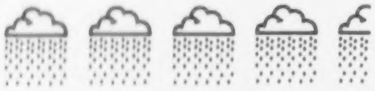
WOW! The Wonders of Wetlands

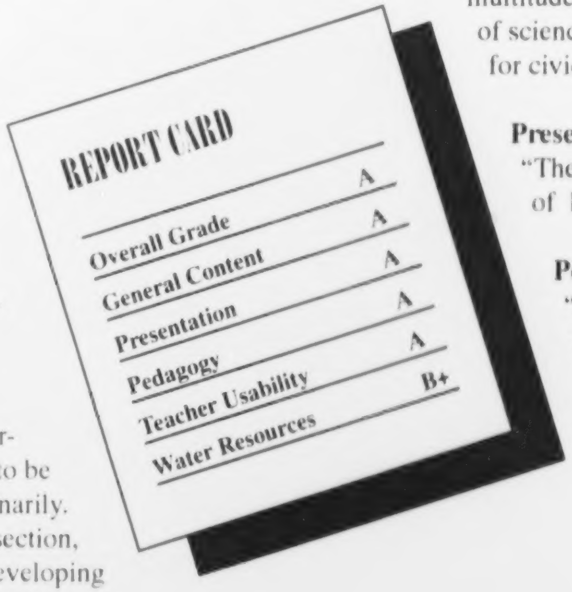
Environmental Concern, Inc., and
The Watercourse
c/o 201 Culbertson Hall
Montana State University
Bozeman, Montana 59717-0570

$15.95. 1995. 330 pages.

"Wow! The Wonders of Wetlands" is divided into two core parts: an extensive teacher background section followed by 44 activities organized within five chapters: an introduction to wetlands, the wetlands community, the role of water in wetlands, the role of soil in wetlands, and wetlands and people. Background information is cross-referenced to specific activities, designed to be taught thematically and cross-disciplinarily. A glossary, an educational resources section, and an appendix detailing plans for developing a schoolyard wetland habitat are also included.







REPORT CARD

Overall Grade	A
General Content	A
Presentation	A
Pedagogy	A
Teacher Usability	A
Water Resources	B+

COMMENTS

General Content

"A must for any water science teacher's shelf!" "'WOW' offers a multitude of activities to choose from." "It provides a broad scope of science-based, hands-on explorations, as well as suggestions for civic involvement."

Presentation

"The book is actually two: a textbook followed by a plethora of lesson plans."

Pedagogy

"Rich in information and ideas ... more a resource book to be studied than a quick source of lesson plans."

Teacher Usability

"The activities do take some sorting through because there is so much information." "The book can be used anywhere one has access to a wetland."

Specific Content on Water Resources

While not a curriculum on water, "WOW! The Wonders of Wetlands" provides broad coverage on the topic of wetlands.

Wet 'n' Wild

Grade Level
K-12

Subject Areas
Biology, Ecology, Art

Duration
5-90 minutes outdoors, depending on grade level. 30-60 minutes to complete field guide pages

Setting
Classroom and wetland

Skills
Gathering, organizing, and interpreting information

Charting the Course
This is a super activity for learning about wetland communities. It can be tied in nicely with "Tracking Plants and Keeping Track," which asks students to collect and record plant specimens. "Wetland Weirdos" has students look at special adaptations in wetland plants and animals.

Vocabulary
habitat, endangered species

Summary

Many people think wetlands are dangerous places full of mosquitoes, monsters, and poisonous snakes. Let your students see firsthand that the creatures living in wetlands are ones we enjoy, need, and want to protect. Students will collect and observe wetland animals and make a wildlife field guide.

Objectives

Students will describe the living and nonliving components of wetland habitats.

Materials

- *copies of Wet 'n' Wild Mini Field Guide*
- *paper, pencils, clipboards*
- *colored pencils, felt-tip pens, or crayons*
- *collecting equipment (see Equipment for Collecting Critters for specific materials needed)*
- *"wettable" clothes and shoes or boots, change of clothes*
- *field guides*

Making Connections

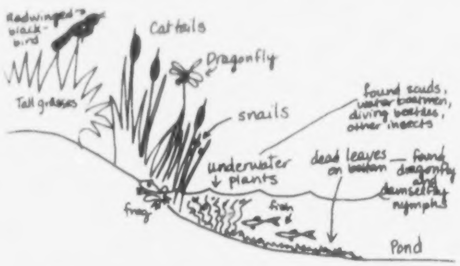
Careful field collection techniques support an appreciation of adaptations unique to wetlands animals. Skillful observation and proper data collection and recording methods are critically important to good field technique.

Background

Wetlands are so often depicted as dark, dangerous places full of undesirable creatures that many of us tend to believe it! However, even skeptics who visit wetlands will admit that they are actually beautiful places full of interesting and beneficial animals.

The kinds of animals in a wetland depends on the type of wetland, the plants that grow there, and the quality of the water (salty or fresh, clean or polluted). Field guides to wetlands, ponds, mammals, fish, insects, birds, and wildflowers, (see Resources, p. 327) are helpful identification tools. Some of the common wetland fauna are shown in the Wet 'n' Wild Mini Field Guide on p. 103.

A habitat is the place where an animal finds food, water, shelter, and space, in the arrangement that suits its needs. Different animals often require different habitats, though many may share the same habitat. The habitat for a


Redwinged blackbird
Cattails
Dragonfly
Tall grasses
snails
found scuds, water boatmen, diving beetles, other insects
underwater plants
dead leaves on bottom
found dragonfly and damselfly nymphs
frog
fish
Pond

Wet 'n' Wild Mini Field Guide

Most animals listed here are found in freshwater wetlands, though some may be found in brackish or saltwater wetlands. For some salt marsh ideas, see the "Salt Marsh Players" cards, p. 170.

Aquatic Insects and Their Kin: Dragonfly, damselfly, stonefly, mayfly, alderfly, dobsonfly, cranefly, caddis fly, mosquito, and others, found on and above water; their larvae (nymphs) found in the water. Water-dwelling adults and larvae: water boatman, predacious diving beetle*, giant water bug*, water strider, backswimmer*, whirligig beetle, crayfish, sideswimmer, water mite.

Other Insects and Their Kin: Horsefly, deerfly, butterfly, moth, tick, spider*

Fish: Mudminnow, killifish, various sunfishes, pickerel, darter, catfish. Others in salt water.

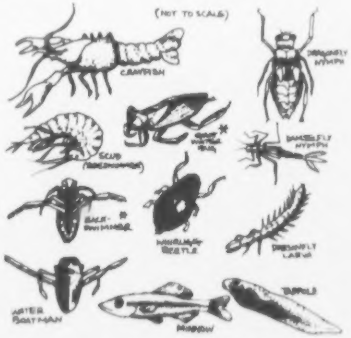
Amphibians: Frog (green, bull, pickerel, leopard, carpenter, wood, green tree, spring peeper), salamander

Reptiles: Skink (small lizard), turtle (bog, snapping,* mud, painted, wood, spotted, musk, terrapin* [brackish water]), snakes (brown, ribbon, water*), alligator* (southern United States)

Birds: Wide variety of ducks, geese*, wading birds (herons, etc.), hawks and eagles*, owls*, songbirds (such as red-winged blackbirds and woodpeckers), shore birds (coastal)

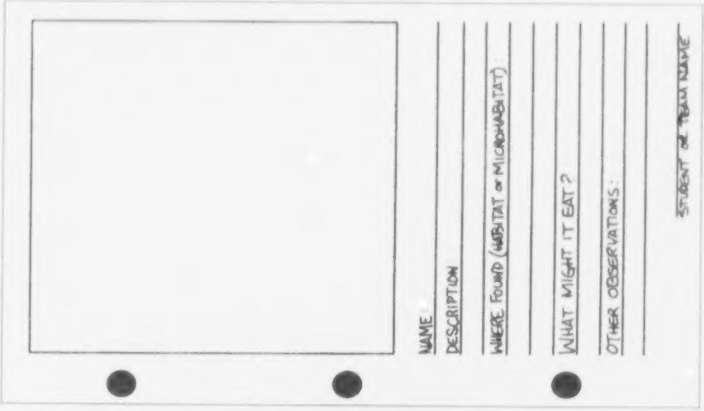
Mammals*: Raccoon, fox, shrew, meadow vole, mouse, mink, muskrat, nutria, beaver, river otter, deer, moose (northern United States)

*** May bite if handled.**


(NOT TO SCALE)
CRAYFISH
DRAGONFLY NYMPH
GIANT WATER BUG *
SCUD (SIDESWIMMER)
DAMSELFLY NYMPH
BACK-SWIMMER *
WHIRLIGIG BEETLE
DOBSONFLY LARVA
WATER BOATMAN
MINNOW
TADPOLE

Sample Field Guide Sheet

Save paper. Make two copies of the blank field guide sheet below. Place the two together on an 8 ½ by 11-inch piece of paper, then photocopy and cut into individual sheets. Students may jot notes on the back.


NAME
DESCRIPTION
WHERE FOUND (HABITAT or MICROHABITAT)
WHAT MIGHT IT EAT?
OTHER OBSERVATIONS:
STUDENT or TEAM NAME

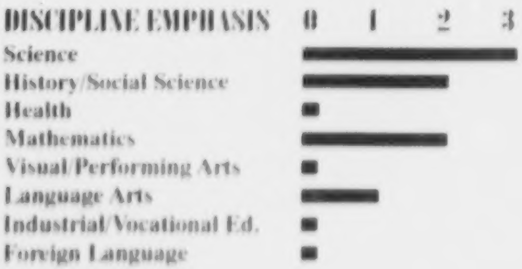
BEST COPY AVAILABLE

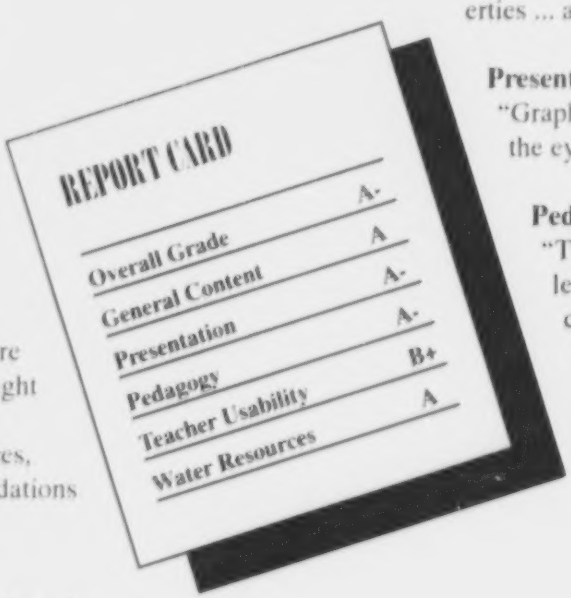
The Comprehensive Water Education Book

International Office of Water Education
Utah Water Research Laboratory
Utah State University
Logan, Utah 84322-8200
(800) 922-4693

$8.75. 1994. 335 pages.

"The Comprehensive Water Education Book" is designed to promote water literacy, specifically an understanding of water, water management, and water-related ecological and economic issues. Extensive teacher background sections are followed by lessons, which can be taught randomly or sequentially. Additional sections include supplemental resources, recreational activities, and recommendations for field methods and equipment.





REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	A-
Teacher Usability	B+
Water Resources	A

COMMENTS

General Content
"This curriculum is very thorough on chemistry and physical properties ... a comprehensive reference tool about water."

Presentation
"Graphics help to elucidate the lessons." "The pages are easy on the eyes."

Pedagogy
"This book is well thought out - structured with cooperative learning in mind." "Offers very clear explanations of classroom management techniques and cooperative learning opportunities."

Teacher Usability
"The lessons are organized with two or three sequential activities and interesting extensions." "The clear background information is helpful." "Time suggestions are lacking, as is differentiation between actual activities and teacher-led discussions."

Specific Content on Water Resources
This material covers water science thoroughly.

Lesson Forty

Framework
Reference
2.12

WATER POLLUTION

Vocabulary:
- sewage
- pollution
- organic matter
- microscopic organisms
- point source
- non-point source

Grade: 4-6

Purpose: This lesson will introduce students to the concept of water pollution.

Materials

Activity One
- 2 one-quart jars with lids
- methylene blue
- glucose sugar
- sodium hydroxide (lye)
- scales or balance
- graduated cylinder

Preparation: High school chemistry labs should have the chemicals listed. Dissolve 1 Tbsp. of glucose in 1/2 liter of water. Dissolve 1 Tbsp. of sodium hydroxide in another 1/2 liter of water. Add six drops of 1% methylene blue solution to the sodium hydroxide solution. (You can err by 100% and still have the demonstration work.)

Activity Two
- 8 pint jars (1/2 with lids) per group
- masking tape
- pencils
- water
- laundry detergent
- plastic cups
- cooking oil
- vinegar
- cotton
- funnel
- soil

Activity Three
- plastic spoons
- medicine droppers
- food color (small dropper vials)
- plastic cups
- water

Exploration

Activity One

1. Do this activity as a demonstration. Hold up a clear glass jar containing the methylene blue solution and say, "This container of water represents a local lake." The blue color represents oxygen in the water. Then pour the contents of the second jar, containing clear liquid (glucose solution), into the lake. Say, "We have just added some **sewage** to our lake."

Indicate that the sewage will now react with the chemicals and organisms in the lake. Get student reactions and feelings about sewage. Introduce the word **pollution**. As the discussion progresses, the blue color will disappear, indicating that the oxygen is gone. Ask students to **speculate** what effect this would have on life in the lake.

2. Ask students how oxygen might be re-added to the lake. Place a lid on the jar and shake the colorless solution. The blue color should reappear and then disappear again. This process can be repeated over and over until the sewage (glucose) is consumed.

Concept Development

1. Explain that the demonstration is very similar to what happens in polluted streams. Sewage is mostly **organic matter**. The sewage in the demonstration was sugar. In streams and lakes, **microscopic organisms** use the sewage as food and produce CO_2. This uses up the oxygen in the water. In the demonstration, a blue chemical does the same thing.

   If the organic pollution in a lake or stream is too great, then all of the oxygen will be used up and nearly everything will die, except bacteria that produce bad odors (rotten egg gas).

Activity Two

2. Indicate that there are many ways in which water becomes polluted. First, there is natural pollution. Soil, leaves, and tiny organisms get into water from nearby land. Then, there is pollution caused by people. In farm areas, fertilizers and insecticides get into streams and lakes. So does runoff from animal feed lots. In industrial areas, harmful wastes are dumped into the water from factories and refineries. In cities, sewage and runoff from trash dumps find their way into the water. This, in turn, seeps into the groundwater, which is where a number of cities and most rural areas get their drinking water. Water pollution is a very serious problem.
3. Form cooperative learning groups. Have the **materials managers** pick up a Pollution Worksheet and all listed materials. Instruct groups to do the listed activities.
4. Discuss results. Expand the discussion of pollution to include information on the following:
   - urban runoff
   - agricultural runoff
   - septic system failures
   - natural sources

   Point sources of pollution:
   - sewage treatment plants
   - leaking or overflowing sewer lines
   - livestock feedlots
   - sanitary landfills
   - illegal waste dumping
   - improper pesticide use

   These topics can be presented as teacher directed information or can be assigned as student research reports.

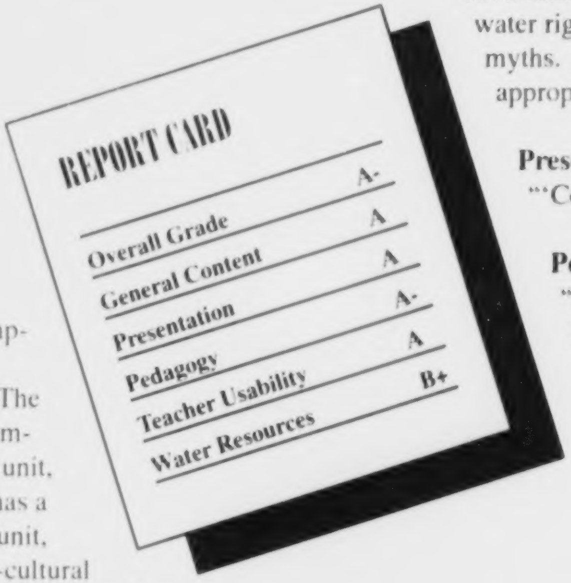
Water Wisdom

Alameda County Office of Education
313 West Winton Avenue
Hayward, California 94544-1198
(510) 887-0152

🌧🌧🌧🌧

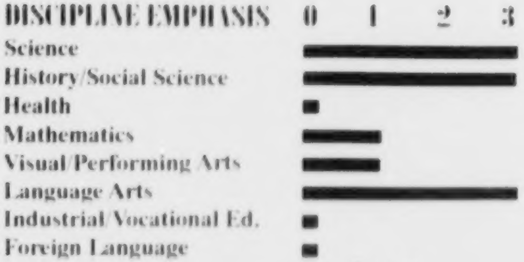
$14.50. 1990. 119 pages.

"Water Wisdom" is the second supplement to the *California State Environmental Education Guide*. It consists of three instructional units for grades 4 - 8. The focus of the units is on expanding students' thinking to view water as important, not only for human consumption, but for the survival of all living organisms and the planet as a whole. The first unit, "Water Nurturing Nature," emphasizes science concepts; the second unit, "Water Rights and Responsibilities," has a social studies emphasis; and the third unit, "Water Symbolism," focuses on cross-cultural literature. The California Water Map is also included.



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A
Pedagogy	A-
Teacher Usability	A
Water Resources	B+



COMMENTS

General Content

"This curriculum would be an effective supplement to a science or environmental curriculum, as it focuses on water use issues, on water rights, and a multicultural/literacy exploration of water myths. The lessons are well thought out and seem especially appropriate for California."

Presentation

"'Copy Cat' pages are clear and easily reproduced."

Pedagogy

"Lessons are integrated across the curriculum." "Excellent literature component."

Teacher Usability

"Good background information; lessons are easy to follow." Home learning connections tie learning to the family. "Good tool for heightening students' awareness of water conservation."

Specific Content on Water Resources

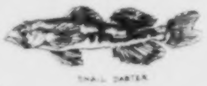
"A rich opportunity to explore water from a variety of viewpoints." "Missing some of the components needed to be considered a comprehensive water curriculum."

Copycat Page

Name ____________________

CASE STUDY: ANIMAL RIGHTS VERSUS HUMAN RIGHTS

With your partner, read the story and answer the questions that follow it. Then each of you write your own ending to the story.



THE LITTLE FISH VERSUS THE BIG DAM

My name is Gloria Lee and I'm in eighth grade. I want to tell you about a big conflict here in Tennessee and around the country—all because of a little fish.

Usually it's quiet and peaceful here. My family and I live on a farm in a beautifully lush, green valley. The Little Tennessee River meanders through our valley, making the soil rich, fertile, and good for farming. In fact, the whole valley is filled with little farms and pretty white clapboard houses like my family's.

I think this valley is a wonderful place to live, but I'm not the only one who has thought so. Some archaeologists found two Indian sites that prove people have been living here for 10,000 years!

The river is one of the things I like best here. When I want to be alone, I like to paddle around the river in our canoe—just sitting and thinking, and sometimes doing some fishing. As everyone around here knows, the Little Tennessee River has the best trout fishing in Eastern Tennessee, but it's not a trout that caused the commotion I'm going to tell you about.

It all started about 16 years ago when the Tennessee Valley Authority, or the TVA as we call it, decided to build a big dam right here in our valley. The TVA said that the dam was important because it would use water running through it to produce electricity. The TVA also said that the dam would help control the flooding problems we sometimes have in Tennessee. While the dam would back up the river and cause it to flood half the valley, it would make a big reservoir and recreation area where people could boat, fish, and swim. This Tellico Dam would cost 120 million dollars.

Some people liked the idea of a reservoir where they could water-ski and boat, but as you might guess, other people weren't too happy about having their homes and farms flooded to make a big reservoir. And it wasn't just their farms they wanted to save—it was the beautiful valley and the Indian sites, too. These people fought hard to keep the dam from happening. But the TVA fought harder, and won.

When the dam was about half built, something unexpected happened. A biologist from the University of Tennessee named David Etnier was doing some research in the Little Tennessee River. He was snorkeling there when a small fish that he had never seen before darted out from under a rock and gulped a snail. Later he figured out that the tan, 3-inch-long fish was a snail darter. This fish species used to live throughout eastern Tennessee rivers, but so many dams have been built in the region that this short stretch of the Little Ten-

3. Who do you think has more rights to the water—people or the fish? Provide reasons to support your answer.

4. What are the good and bad consequences of the dam being completed?

Good Consequences	Bad Consequences

5. What are the good and bad consequences of the dam not being completed?

Good Consequences	Bad Consequences

6. What do you think should happen? Do you think the dam should be completed?

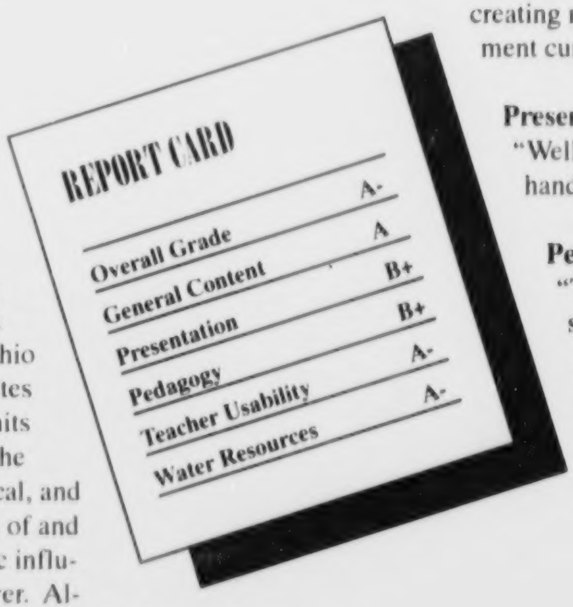
7. Who do you think should decide what to do?

Always a River

United States Environmental
Protection Agency
Attn: Helen Fischer
Office of Research and Development
26 West Martin Luther King Drive
Cincinnati, Ohio 45268
(513) 569-7781

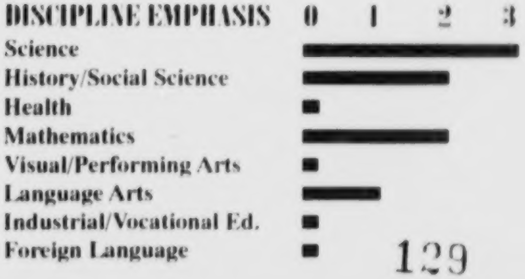
No charge. 1991. 284 pages.
Quantities are limited.

"Always a River, a Supplemental Environmental Education Curriculum on the Ohio River and Water" offers a series of activities that focus on the Ohio River and its importance to the six states through which it flows. Four broad units explore the Ohio River in relation to the total ecosystem; the biological, physical, and chemcial aspects of water; human use of and impact on the Ohio River; and historic influence and implications of the Ohio River. Although regional in focus, activities can be modified to work elsewhere.



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	B+
Pedagogy	B+
Teacher Usability	A-
Water Resources	A-



COMMENTS

General Content

"Materials provide a good example that other regions can use when creating regionally specific water resource and watershed management curricula."

Presentation

"Well designed; easy to read and plan." "Overheads and handouts are excellent."

Pedagogy

"This curriculum encourages critical thinking and employs science process and decision-making skills ... explores conflicting points of view." "Needs to be more connected to students' lives [with more emphasis on stewardship]."

Teacher Usability

"The lessons offer extensive background information." "Good glossary; objectives are clear and expressed in behavioral terms." "May be difficult to apply to California."

Specific Content on Water Resources

"Good overall treatment of water resource education topics." "Information pertains primarily to the Ohio River region."

Activity

How Rivers Are Formed

Objective Students will create models of rivers, identify river features, and compare their models to actual rivers.

Setting Classroom or laboratory

Duration One 40- to 60-minute period

Subject Geography, Science

Skills Recording Data, Media Construction, Psychomotor Development, Small Group Work, Decision-Making, Inference, Communication, Comparing Similarities and Differences

Grade Level 3-8 (Conduct as a demonstration for younger students.)

Vocabulary tributaries meanders alluvium cutoff oxbow lake

Background Information Refer to Unit I, Sections A-1 through A-3.

Materials

- Sand table/sand box.
- Pitcher or other container of water.
- Paper and pencil.

Procedure Explain to students that they will be creating miniature rivers in this demonstration. Break older students into small groups to perform the activity, if space and materials permit. For younger students, perform the demonstration yourself.

1. Mound the sand or soil into a small hill.
2. Pour water slowly onto the sand or soil.
3. Have students draw a picture of what they see.
4. Have students identify the source of the river and its mouth, then label these features on their diagrams.
5. Ask students if they can identify other river features. If students are not already familiar with tributaries, meanders, oxbow lakes, cutoffs, and other features, allow time for them to research in geology textbooks or other reference materials.

Procedure *(continued)*

6. Have students label their diagrams with any additional river features, then discuss what they have found.

Extension/ Evaluation Have students experiment with different slopes in the sand boxes and different water flows to see the effect on the formation of their rivers. Encourage students to draw pictures of rivers formed on shallower and steeper slopes and with faster and slower flows. Compare these rivers and discuss the differences.

If there is a river area nearby where students can observe the formation of oxbows, waterfalls, deltas, meanders, or other river features, arrange a field trip.

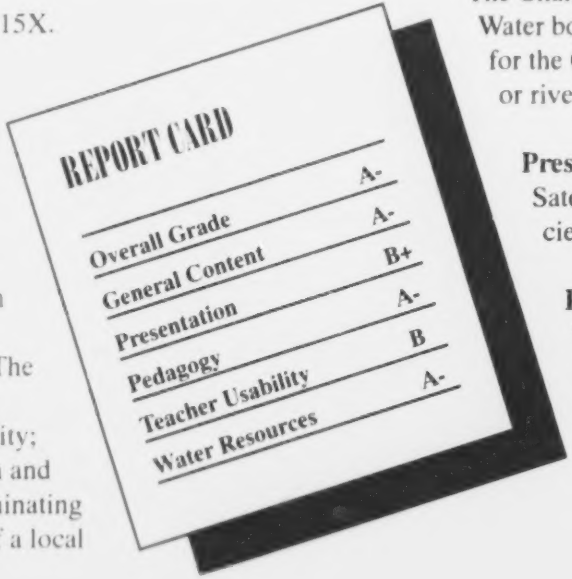
Understanding Our Environment

National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3000
(800) 722-6782

🌧 🌧 🌧 🌧

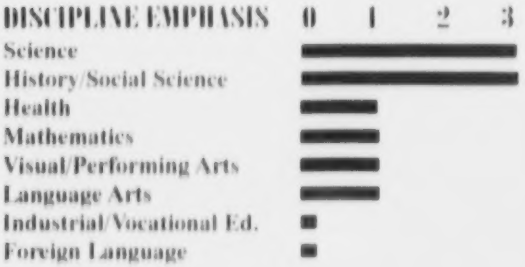
$35.00. 1995. Box format. Item PB115X.

"Understanding Our Environment" consists of eight books and support materials including color transparencies and posters packaged together in one box. One unifying project, supported by a collection of activities is presented in each of seven units entitled The Planet, Air, Water, Land, Life, People, and Challenges. The water unit focuses on the water cycle, sources of fresh water, and water quality; specific issues include water pollution and preservation of the environment, culminating with an activity involving the study of a local waterway.



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	B
Water Resources	A-



COMMENTS

General Content

"Two of the seven books in this curriculum pertain to water issues. The Challenge simulation is well thought out and organized. The Water book gives a good overview and would prepare students for the Challenge activity." "An in-depth study of a local stream or river provides the unifying focus for this unit."

Presentation

Satellite images, a water cycle poster, overhead transparencies, a collection of maps, and fact sheets are included.

Pedagogy

"Activities are hands-on and process oriented; encourages higher order thinking skills." "Assessment is embedded."

Teacher Usability

"Excellent background information is provided for the teacher." "Needs more student sheets to support the lab activities."

Specific Content on Water Resources

"Excellent in-depth focus on the water cycle." "Although limited in scope, the topics selected are covered thoroughly."

Water Use and Quality

The Information Sheets on water distribution and quality (pages 18–22) may be photocopied for classroom distribution.

Activity: How Much Water Do You Use?

Students investigate their personal water use and consider the effect of domestic water use on water supply and water quality.

The following estimated water-use information may be helpful:

1. The average volume of water used per person per day in the United States is 325 liters (1 gallon = 3.78 liters.)
2. Experts estimate that 40% of domestic water use in the United States is for flushing.

Some guidelines for common activities:

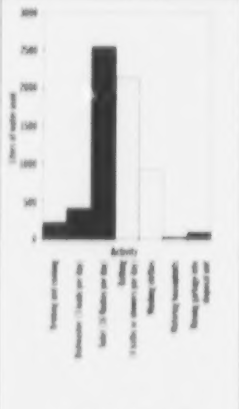
ACTIVITY	ESTIMATED VOLUME
Taking a shower	190 L (50 gal)
Taking a bath	114 L (30 gal)
Washing dishes by hand	38-114 L (10-30 gal)
Washing dishes by machine (per load)	38 L (10 gal)
Washing clothes by machine (per large load)	228 L (60 gal)
Flushing the toilet (per flush)	22.8 L (6 gal)

(Reminder: In liquid measure, 1 gallon = 3.78 L, 1L = 0.26 gallon)

Source: *Environmental Science Activities Kit*, Michael L. Roa, West Nyack, NY: Center for Applied Research in Education, 1993, p. 114.

Selected answers to "Industrial and Agricultural Use" in "How Much Water Do You Use?"

In the United States, on average, factories use water 2.2 times before it is discarded. Water used by agriculture can be saved by making irrigation systems more efficient.



Adapted from *Earth: The Water Planet*, by Jack E. Gartrell, Jr., Jane Crowder, and Jeffrey C. Callister. Washington, DC: National Science Teachers Association, 1989, p. 85.

Suggested Resource

To purchase useful materials on water quality, pollution, and use, contact the Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994.
Telephone: 703-684-2400 or 1-800-666-0206

What Did You Find? What Do You Think?

Compare your findings with those of your classmates and note any common patterns you find. Then answer the following questions.

1. Which domestic activities consume the most water?
2. Which uses require water of drinking quality?
3. Does your family reuse any water?
4. Can you suggest ways to use water more economically at home?
5. Think of examples of the ways water is used in your community—for example, for car washes and street cleaning. Can you suggest ways to save some of this water that won't affect quality of life?
6. Can you think of ways of using any water again for other purposes?
7. Do you think people use more water today than they did 50 years ago? Why or why not?
8. What do you think will happen if we take more and more water from our rivers, streams, and other sources?

Water Quality

1. How do your activities affect the quality of your water supplies?
2. Make a list of all the substances you and your family use that are added to water and go down the drain, such as detergents and bleach. Remember to include any fertilizer and weed killers used on the lawn. Do you think any of these substances eventually get into the ocean?
3. Discuss what you can do at home, in the yard and garden, and in leisure activities to protect the quality of your water supplies. Use reference materials to find information to support your ideas.
4. Write a short report on your findings.

Industrial and Agricultural Use

1. How do you think water is used by industry? By agriculture?
2. Do you think any of the water used by industry or agriculture can be recycled? Write your thoughts about this and share any information that you may have gathered from reference materials.

BEST COPY AVAILABLE

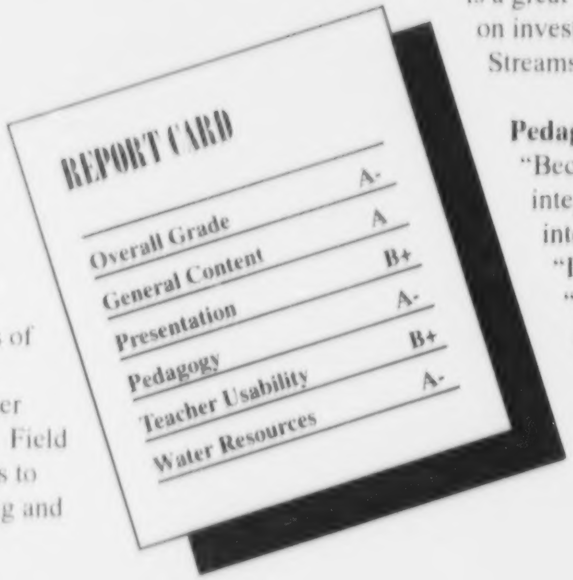
Hands On Save Our Streams

Save Our Streams
The Izaak Walton League of America, Inc.
707 Conservation Lane
Gaithersburg, MD 20878
(800) 284-4952

$18.50. 1995. 201 pages.

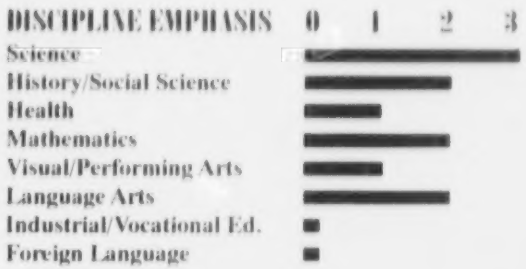
☁ ☁ ☁ ☁

This teacher's manual is based on the grassroots river and stream protection program of the Izaak Walton League of America. Classroom activities integrate science, social science, language arts, and mathematics to introduce the concepts of watershed, the hydrologic cycle, the relationship between land use and water quality, and water quality monitoring. Field trips provide opportunities for students to apply skills in water quality monitoring and restoration activities.



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	B+
Pedagogy	A-
Teacher Usability	B+
Water Resources	A-



COMMENTS

General Content

"A very well-rounded hands-on activity-based curriculum." "This is a great concept- learning about streams, watersheds, and hands-on investigations!" "A very comprehensive study of 'Save Our Streams' issues."

Pedagogy

"Because it focuses on field work, it may be difficult to integrate this in urban California." "This represents an interdisciplinary approach with real-world applications." "Its field activities help build attitudes of stewardship." "Actual lessons ... do not necessarily stand out from other material."

Teacher Usability

"This provides an excellent resource list and information on making field collecting equipment." "A significant amount of materials needs to be gathered." "The video on volunteer stream monitoring would also be helpful and the video script has been translated into Spanish."

Specific Content on Water Resources

"Excellent connection made between class study and real involvement with water quality monitoring."

[illegible]

[illegible] [illegible]

[illegible] [illegible]

Key Words: [illegible]

Materials: [illegible]

Advance Preparation: [illegible]

Procedure: [illegible]

[illegible]

Skills Learned: [illegible]

Extension Activities:

1) [illegible]

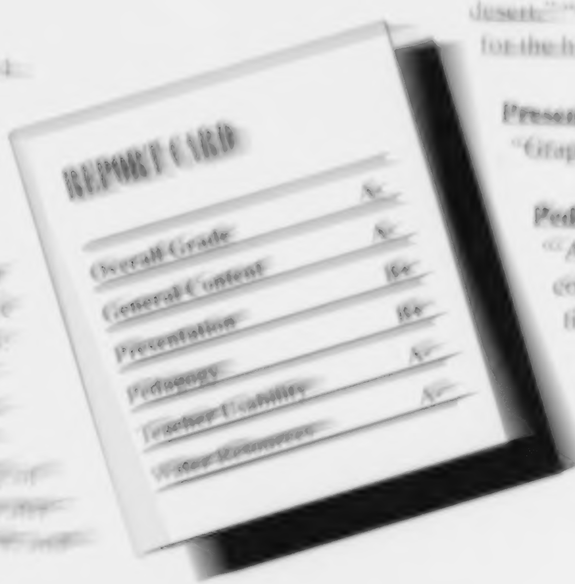
2) [illegible]

A Sense of Water

Southern Arizona
Water Resources Association
18 North Tucson Boulevard, #106
Tucson, Arizona 85716
(520) 881-3939

$10.00 plus $4.00 shipping. 1984. 134 pages.

"A Sense of Water" provides a broad range of water-related activities with particular emphasis on water availability in the arid Southwest. The activities are organized in six sections: Water Magic, The Wonders of Water, Less Water Climates, Water Working, Water Warnings, and Water Wisdom. Activities can be taught independently of one another or sequentially within a water [illegible]



COMMENTS

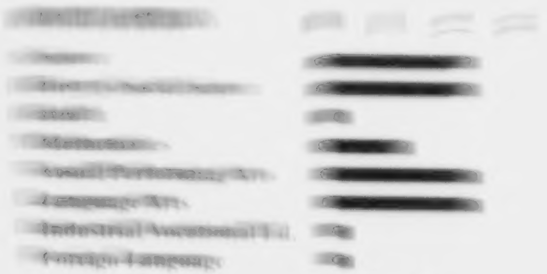
General Content
"The material offers a good idea of how valuable water is in the desert." "Communicates a love for water, for natural artistry, and for the human need to care for natural resources."

Presentation
"Graphics and photos enliven the text."

Pedagogy
"'A Sense of Water' focuses on the affective as well as cognitive domains." "Offers clear, measureable objectives." "Integrated across all disciplines."

Teacher Usability
"Teacher background material could be expanded." "Lessons are well organized and succinct." "Outstanding glossary and subject/topic index."

Specific Content on Water Resources
[illegible] intense [illegible] rein in this [illegible]



601

Soggy Situations

objective

Students will be able to:
- Examine and develop their own attitudes toward water conservation.
- Evaluate possible actions they might take when confronted with a dilemma regarding water use.

materials

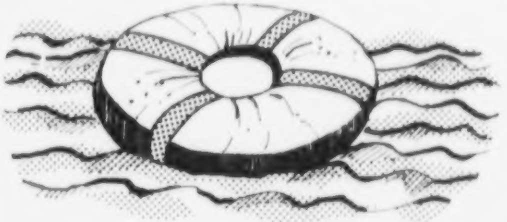
Soggy Situation Cards

background

There are no right or wrong answers for the following situations. This activity provides a forum for students to explore their own attitudes toward water use and develop a heightened awareness of the need for positive action if we intend to conserve this limited resource.

introduction

Explain that the students will be given potential situations involving their opportunities for involvement in water conservation. They will be required to make their own decisions and evaluate the decision of others.



Chapter Reference

Water Wisdom

Grades

2-6

Subject

Social Studies, Science

Length of Activity

One classroom session

Concept

There are many methods of water conservation. (F)
Personal attitudes, beliefs, and values influence the success of water conservation. (H)

Key Vocabulary

choice, individual, priorities

Credits

Adapted from "Ethi-Reasoning activity" from Project Wild
Copyright 1983 Western Regional Environmental Education Council
Used by permission

---

notes

activity

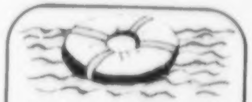
- The class is divided into groups of 4 or 5. Each group receives a stack of Soggy Situation Cards, to be placed face down in the center of the group.
- The first player draws a card and reads the situation and the options to the group. He then gives the decision he has chosen and briefly describes the reasoning involved.
- Without consultation, the other players decide to what degree each agrees with the first player's answer. Rating is done on a scale of zero through ten, with zero representing total disagreement and ten total agreement.
- Each player in turn announces his rating of the first player's decision and the reasons for that rating. It is not necessary for the students to reach a consensus. The purpose of this is to provide students with an opportunity to examine, express, clarify and take responsibility for their own reasoning.
- The card is then returned to the bottom of the stack and the next player selects the next card. Continue this process until all students have had an opportunity to express their decision and rationale about a "situation."

closure

Discuss the activity with the whole group. Reflect on especially difficult situations, and feelings that may have been generated by a disagreement with a decision. Reinforce that there are no right or wrong answers and that each person must come to terms with his/her own feelings about water conservation and appropriate actions.

evaluation

Have the students try to think up other situations they might get into where they could take action to save water.



SOGGY • SITUATIONS

Your family has just bought a new house and you go to the plant store with your mom/dad to pick out some plants.

SHOULD YOU

a) Stay out of the way and play while they make their choices?
b) Suggest that since you now live in the desert, low water using plants would probably be easier to take care of?
c) Tell them to get lots of jungle plants so you can play like a monkey in the yard?

SOGGY • SITUATIONS

You go to brush your teeth and when you've finished with the water, the faucet won't shut all the way off and the water keeps dripping out.

DO YOU

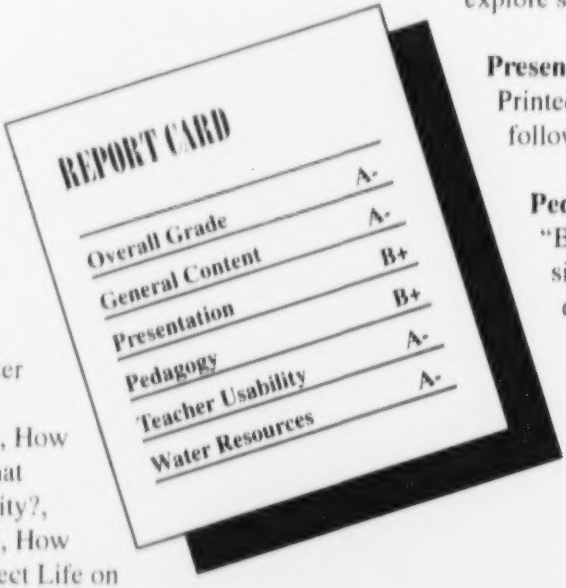
a) Tell your parents and ask them to fix it?
b) Don't say anything and hope it goes away?
c) Try to fix it yourself?
d) Try to plug up the drain to save the water that is dripping?

Gee-Wow! Adventures in Water Education

The Ecology Center of Ann Arbor
117 North Division Street
Ann Arbor, Michigan 48104
(313) 995-5888

$12.00. 1996. 70 pages.

"Gee-Wow! Adventures in Water Education" teachers concepts related to water, groundwater, and pollution prevention. Activities are grouped into eight sections, as well as cross-referenced by subject area, activity type, and grade level. The sections are entitled Why Is the Earth Called the Water Planet?, How Is Water Stored and Moved in Planet Earth?, Where Is Water Found Underground?, How Does Water Move Underground?, What Natural Factors Influence Water Quality?, How Do People Affect Groundwater?, How Does the Quality of Groundwater Affect Life on Earth?, and How Can We Protect the Quantity and Quality of Groundwater?



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	B+
Teacher Usability	A-
Water Resources	A-

COMMENTS

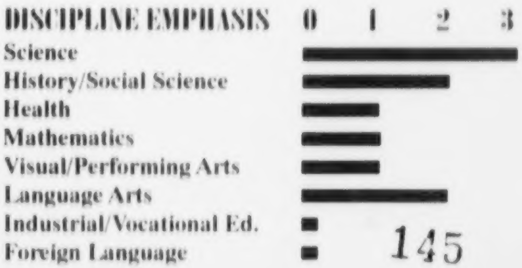
General Content
"An interesting presentation of groundwater ... a variety of lessons explore soil particles and their role in the movement of water."

Presentation
Printed on recycled paper. "Well laid out materials are easily followed." "Graphics need improvement."

Pedagogy
"Background and extensions to each lesson are not extensive, but adequate." "Labs are simple, but involving and directly applied to concepts."

Teacher Usability
"Michigan-based lessons are adaptable." "Both lessons and key concepts are succinct."

Specific Content on Water Resources
"Material focuses on Michigan, but can be used anywhere." "Students will obtain a good basic understanding of water resources."



The Human History of Water Town:

An almost-true tale in one act

SUMMARY: This is a story about who uses water in a community. As the teacher tells the story, students will be called to the front of the class and asked to demonstrate part of the story in a specific way. Afterwards, they will be asked to draw a part of the story. Older students calculate the specific volumes of water given, to develop math skills. Younger students can use relative terms, like "a lot" or "a little."

OBJECTIVES: To show that surface water or groundwater can be used to meet water demand, and that there is a greater quantity of groundwater than surface water. To demonstrate that different quantities of water are used for different activities. To show how water consumption increases with increased human activity as a town grows.

VOCABULARY WORDS:
company, groundwater, well, pump
TIME REQUIRED: 35 minutes
MATERIALS NEEDED:
5 Cups with water in them
1 Container (preferably clear) that can hold 5 cups of water
1 Container (preferably clear) that can hold 10 cups of water
1 Empty bucket that can hold 20 cups of water
Pitchers or empty pop bottles containing 15 cups or more of water
Drawing materials
5 Copies of the "Family" name tag and 1 copy of each other name tag
Masking tape
1 Measuring cup

PROCEDURE:

1. Read the following story aloud: "Once upon a time, there was a clearing in the woods with a creek running through it. Lots of plants grew by the creek, and got their water from it. Deer came there to drink, birds came there to take their baths, and fish swam in the creek." Ask a student to come up. Tape the "Plants and Animals" name tag to the student's chest. Give the student one cup of water. "This cup of water represents how much water the plants, deer, birds, and fish used each day." Student should stay in the front of the room, holding one cup of water.

2. "One day a family of people came to the creek. 'This looks like a great place to live!" they said. The family set up a camp and later built a house there. They took water from the creek every day to drink, bathe, and wash their clothes." Ask another student to come to the front of the class. Tape the "Family" name tag to her or his chest. Give the student one cup of water. "This cup of water represents the amount of water the family used every day for drinking, bathing, and washing." Student should stay in the front of the room, holding the cup of water.

3. "One day a farmer came to the houses around the little creek. She decided that she wanted to grow tomatoes in the field by the houses. She hauled bucketfuls of water from the creek to water her tomatoes every day." Ask a student to come up to the front of the class, and tape the "Farmer" name tag on her or his chest. In full view of the class, measure 5 cups of water and pour into a container. Have the students count with you as you pour the water into the container. Give the student the container with 5 cups of water in it. "This container of water represents how much water she needed to water her tomatoes every day in the summer." The student should stay in the front of the room, holding the container of water.

4. "More people heard about what a great place this was to live. A builder came and built a subdivision for four families there. Four families came and moved into the new buildings. They all used water for drinking, bathing, and washing things. The little creek did not have enough water in it for a farm and so many families, so each new family dug a deep hole into the ground. In the ground they found water, called groundwater. They attached pumps to suck the water up from the ground and into their houses. By building these wells, they were able to use groundwater in their houses." Have four students to come up to the front of the class and tape "Family" name tags to their chests. Give two students each one cup of water. "These cups of water represent how much groundwater their families used every day." Give two other students each two cups of water. "These families did not pay attention to how much water they used. They wasted water all the time." Students should stay in front of the room, holding their cups of water.

5. "Soon after the subdivision was built, a company that made paper came to the new town. The people in charge of the company built a big factory and began making paper for the people of the town and for others. Many people in the town got new jobs working at the paper company." Ask a student to come up to the front of the class and tape the "Company" name tag to her or his chest. "To begin with, the company was using 20 cups of water every day! After a while, they couldn't get enough water from their wells to supply 20 cups a day. So they reused some of their wastewater, and cut back to 10 cups of water per day." Give the student a bucket, or other container with ten cups of water in it. "The company mixed pieces of wood with water to make paper." Student should stay in the front of the room holding the bucket, or setting it down in front of her or him.

6. "Now the town had many houses, a paper company, and a farm. Each of these used water from the ground or from the creek. There were still plants, deer, birds, and fish that used the water, too."

7. Discussion Questions:

a) Does everybody in our community use the same amount of water? *(No)*

b) Who uses the most water? *(Paper company: ten cups)*

c) Who uses the smallest amount of water? *(One family, or the plants, deer, birds, and fish: one cup)*

d) Who uses more water, a farmer or one household? *(The farmer. The farmer uses 5 cups, and one household uses one cup.)*

e) Who uses less water, the paper company or one household? *(One household. The paper company uses 10 cups, and one household only uses 1 or 2 cups.)*

f) If ten more houses were built by the creek, would all the households together use more water than the farmer? *(Yes. 1 or 2 cups x 10, or 1 or 2 cups added ten times, equals more than the 5 cups that the farmer uses.)* Would they use more water than the paper company? *(The same amount or more. One cup x 10, or one cup added ten times, equals 10 cups, the same amount used by the paper company. Two cups x 10, or 2 added ten times equals 20 cups, more than that used by the paper company.)*

g) How much water was used every day? *(1 cup for plants and animals + 6 cups for four households + 5 cups for the farmer + 10 cups for the paper company = 22 cups per day.)* Have all the students pour their water into one big bucket or other container, and take their seats.

h) Set one cup of water next to the container holding all the water. "This cup is the amount of water used by the plants, deer, birds and fish, before people came to live by the creek. The bucketful is the amount of water used by the whole town after people built houses and a company, and started a farm. When is less water used—when there are only animals and plants living in a place, or when there are people living and working there, too? *(When there are plants and animals alone. There was 1 cup used by plants and animals alone, 22 cups by the end of the activity.)*

i) What happens when more people, farms, and companies move into a town? *(More water is needed.)*

j) Where did they get the water they needed when there wasn't enough water in the creek anymore? *(From a hole they dug in the ground.)*

k) How much water do typical household activities use? *(Share any of the following statistics that you feel relevant.)*

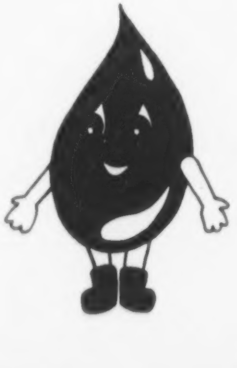
HOUSEHOLD USE
Shower: 5-10 gallons per minute (80-160 cups)
Full Bath: 50 gallons (8,000 cups)
Toilet Flushing: 5-7 gallons (80-112 cups)
Dripping Faucet: 1,000+ gallons per year (16,000+ cups)
Dishwasher: 15-20 gallons (240-320 cups)
Washing machine: 35 gallons (560 cups)
Lawn Watering per 1/2 acre: 35 gallons (560 cups)

EXTENSIONS:

1. Develop the story into a play, with characters, actions, and costumes. Perform the play for another class.

2. Create a bar graph of the amounts of water used by the different characters in the story.

3. Have students draw their own picture of a house, farm, plant, deer, bird, or fish in our town. Each picture should show water being used in some way by the household, company, farmer, plant, or animal. Put all the students' pictures together on a wall bulletin board. Choose a name for the town, and make a sign with the name on it for the display.



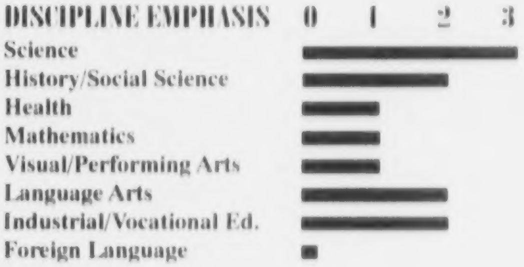
BEST COPY AVAILABLE

Fish in Schools

Adopt-A-Watershed
P.O. Box 356
Hayfork, California 96041
(916) 628-5334

$32.00. 1992. 108 pages.

Students assume the role of biologists and news reporters as they study salmon and steelhead in adopted streams and within the context of watersheds. Eighteen lessons examine the needs of fish, the impact of human activity upon fish life cycles, specific routes of salmon runs, and habitat restoration techniques. Students create an in-class salmonid hatchery and assess the biological health of an adopted stream to determine the feasibility of releasing their fish.



🌧🌧🌧🌧

REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	A
Teacher Usability	B+
Water Resources	B

COMMENTS

General Content
"Utilizes local watersheds as a focal point for educational and political energies." "This curriculum is well balanced and technically accurate."

Presentation
Materials are easily reproduced.

Pedagogy
"A very neat and handy unit matix for Adopt-A-Watershed curricula is provided."
"Excellent and extensive use of community service opportunities." "Specific setwardship and community action are long-term goals of this program."

Teacher Usability
"Information is plentiful - perhaps too dense."
"Excellent resource lists are provided."

Specific Content on Water Resources
"Focus is on Northern California salmon populations and watersheds."

Lesson 12 Fish in Schools

RIVER USES THAT THREATEN SALMON AND STEELHEAD

Focus: People's activities can have a harmful effect on salmonids.

Overview

This lesson is adapted with permission from *California's Salmon and Steelhead* and *Klamath River Studies for Grades 4-6*, Klamath River Education Program, Higgins, et al. Students will identify some human activities that occur that may hurt salmon and will think of alternatives that are less harmful.

Background Information

Fish populations have declined over the last thirty years. It is impossible to identify one cause for this because there are several common activities that all contribute to degrading fish habitat. Among these are:

Mining: The impacts of large-scale mining are still apparent along many tributaries. Huge pilings stand in what was previously the river channel. Small-scale mining is not as harmful, but many dredging operations along a stream can disturb the spawning gravels. Also, the holes left behind can be hazardous for fishermen.

Continued at end of lesson.

Materials

- drawing paper
- pencils
- felt pens
- paint
- crayons
- illustration of *River Uses That Threaten Wild Fish* made into a transparency
- photographs or slides

Advance Preparation

Prepare materials.

Setting the Stage

1. Explain to the students: "In the last lesson we looked at the natural survival pyramid. Today we will look at how people can influence the survival of salmon."
2. Have everyone put on their magnifying glasses.

TIME:

One to two 45-minute periods

GROUPING SUGGESTIONS:

Whole class and individuals

CROSS-CURRICULUM CONNECTIONS

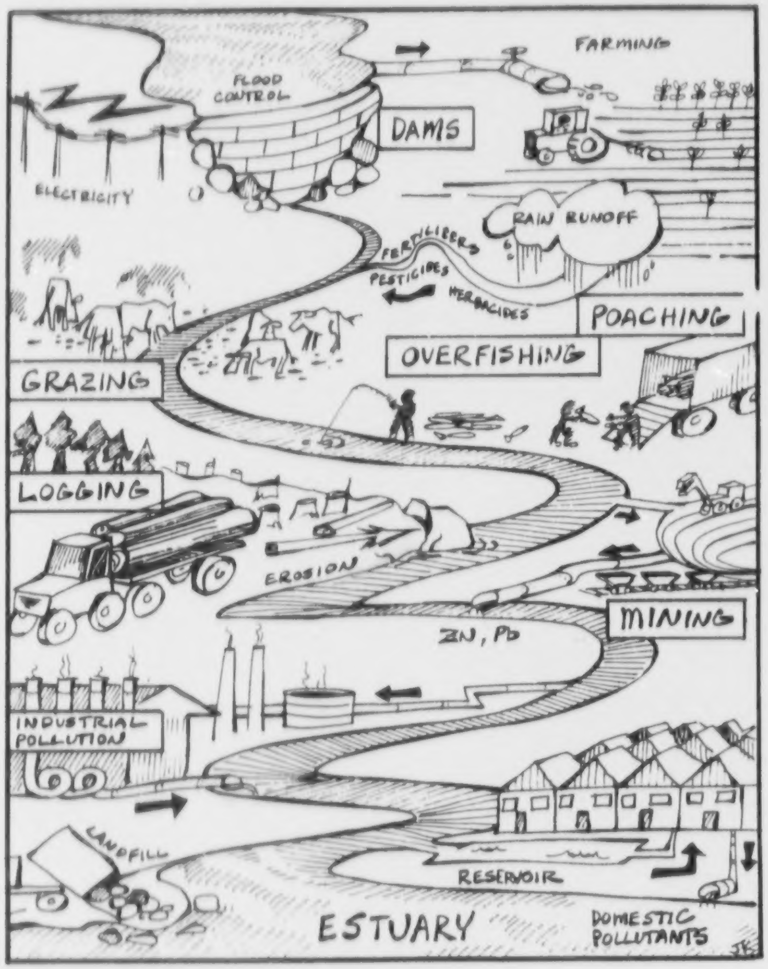
Art
Language arts

PROCESS SKILLS

Fine motor
Group participation
Sequencing
Critical thinking
Problem solving
Interpretation

Copyright © 1992 Adopt-A-Watershed Program

RIVER USES THAT THREATEN WILD FISH

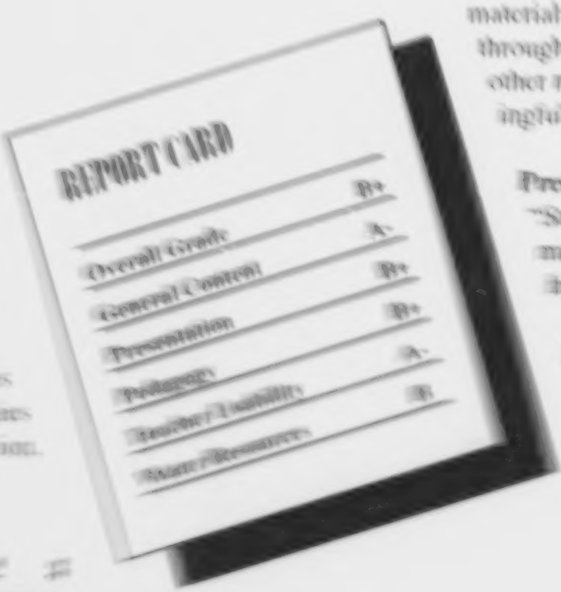

FARMING
FLOOD CONTROL
DAMS
ELECTRICITY
RAIN RUNOFF
FERTILIZERS
PESTICIDES
HERBACIDES
POACHING
OVERFISHING
GRAZING
LOGGING
EROSION
MINING
ZN, Pb
INDUSTRIAL POLLUTION
LANDFILL
RESERVOIR
ESTUARY
DOMESTIC POLLUTANTS
JK

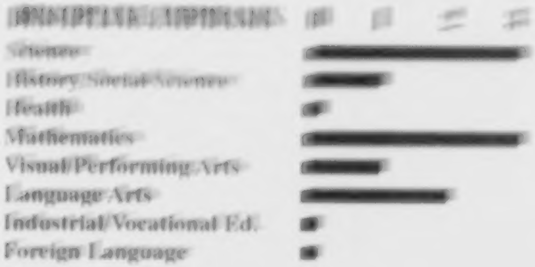
Water Precious Water

AIMS Education Foundation
P.O. Box 8120
Fresno, California 93747-8120
(209) 255-4094

$14.95. 1988. 91 pages.

Produced by AIMS Education Foundation in cooperation with the California Department of Water Resources and Irvine Unified School District. "Water Precious Water" integrates mathematics and science to teach students about water concepts through an application of skills. Twenty-nine hands-on activities explore physical and chemical properties of water, water treatment and distribution, and water quality and conservation.





COMMENTS

General Content
Excellent integration of science and mathematics. "The AIMS materials are an effective, interactive approach to math teaching through other venues. This curriculum, used in conjunction with other material with environmental depth, could provide a meaningful supplement."

Presentation
"Strong, clear reproducibles – attractive to students!" "AIMS materials are easily recognized by their design." "Engaging high quality student worksheets."

Pedagogy
"A high degree of active learning is afforded."

Teacher Usability
"Very direct and easy to implement. Used most easily by teachers who have taken the AIMS training."

Specific Content on Water Resources "Physical and chemical properties of water are addressed; California's water resources and distribution systems are not."

Lesson plans are copied with permission of the AIMS Education Foundation.

MOVING WATER

I. **Topic Area**
Water cycle: evaporation and condensation

II. **Introductory Statement**
This lesson will use a demonstration to introduce the concept of water changing forms through the process of evaporation and condensation.

III. **Science Processes**
a. Observing
b. Generalizing

IV. **Materials**
For class demonstration:
1 hot plate
1 teakettle
2 large metal (aluminum) baking pans
1 tray ice cubes
For students:
activity sheet
scissors and crayons

V. **Key Question**
[illegible]

VI. **Background Information**
[illegible]

[illegible] water droplets. As the droplets fall to the ground you can compare that to precipitation or rain.

Around 75% of the precipitation falls back directly on the oceans. The rest evaporates immediately from the ground or different surfaces or may soak into the earth and become part of the ground water supply. Eventually, much of the surface and ground water returns to the oceans, beginning the entire process over again. Thus the name "water cycle".

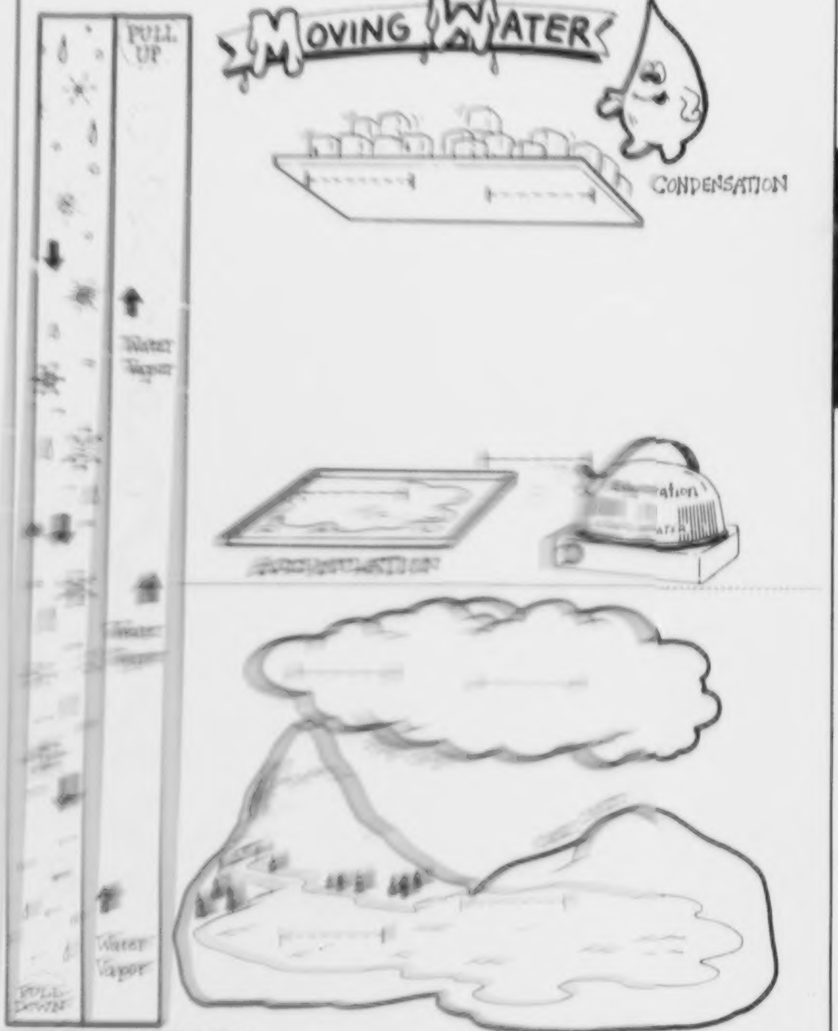
VII. **Management Suggestions**
1. Gather a teakettle, hotplate, 2 large aluminum baking pans and a tray of ice cubes for the water cycle demonstration.
2. Run off a "Moving Water" activity sheet for each student.

VIII. **Procedure**
1. Have students observe a steaming teakettle and describe what they see happening.
2. Ask, "What is the steam made of?" "Where did it come from?"
3. Ask, "Is there some way we can get the steam or water vapor to return to a liquid state?" Ask, "How did they get the liquid to go to vapor?" "How can we get it to go from a vapor to a liquid?" "Can you think of something we use to cool down a substance quickly?"
4. Fill a large aluminum pan with ice and place over steaming teakettle. Observe and discuss.
5. [illegible]
6. [illegible]
7. [illegible]

[illegible]

5. Cut out the cloud and the mountain lake scene. Ask students what objects in the demonstration picture perform the same function in nature. Cut out the clouds and fit them over the pan of ice cubes and put the mountain lake scene over the cookie sheet and teakettle.

Copyright AIMS Education Foundation



GRADES 4-6

Copyright AIMS Education Foundation

BEST COPY AVAILABLE

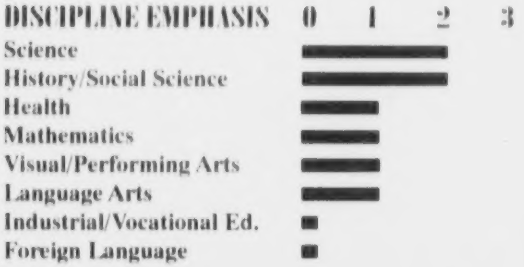
Vista Del Lago Teacher's Guide

Vista Del Lago Visitor's Center
c/o Department of Water Resources
Southern Field Division
P.O. Box 98
31849 North Lake Hughes Road
Castaic, California 91384
(805) 294-0219

No charge. 1995. 36 pages.

Designed to enhance a field trip to the Vista Del Lago Visitor's Center at Pyramid Lake, California, the Teacher's Guide and Student Passport (12 pages) focus on the history of water development in California and the California State Water Project. Background information and classroom activities are offered in the guide, which covers such topics as the importance of water in food production, water distribution and supply, water treatment and conservation, and watersheds. A class set of Student Passports is provided for use during the field trip.

REPORT CARD	
Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B+
Teacher Usability	B+
Water Resources	B



COMMENTS

General Content

"Great preparation for the field trip to Vista Del Lago Visitor Center... equally great supplement to fourth grade social studies."

"This presents an interesting experiential way to approach California water issues."

Presentation

"Clear, concise student pages."

Pedagogy

"While this is not a curriculum, it could be used in conjunction with one to create a comprehensive study."

"A strong use of cooperative learning."

Teacher Usability

This is actually a set of effective lessons used to prepare students for the field trip. "Clever use of stickers could help limited English proficiency (LEP) students meaningfully participate."

Specific Content on Water Resources

Good coverage of water distribution and supply, but the "science of water" is missing.

"A regional study of Southern California."

BIG IDEA: ***There is a historical significance to California's water history.***

OBJECTIVE: Students will become familiar with interpreting timelines by creating their own and sequencing another.

PURPOSE: Today, you will become more familiar with timelines so that when you visit the timeline room at the Vista del Lago Visitor's Center, you will be able to under stand the California Water Story.

LESSON FORMAT: Partners and Cooperative Learning Groups

MATERIALS: **Teacher:**
- sample five item personal timeline
- roll of adding machine tape

Per Team:
- crayons
- five 3x5 cards each
- six California water history glue cards

ADVANCED PREPARATION: 1. Cut the adding machine tape into 36" strips, one per student.

2. Make personal timeline sample.

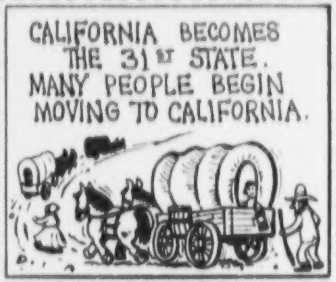
3. OPTIONAL: Teacher can order the "California Water Story" video from the California Department of Water Resources and show to students before they begin to sort the history cards.

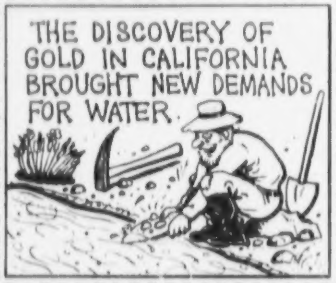
ANTICIPATORY SET: 1. We all have special times in our lives. Here are 5 of mine. Teacher shares five cards, each with a special event and date but NOT in chronological order.

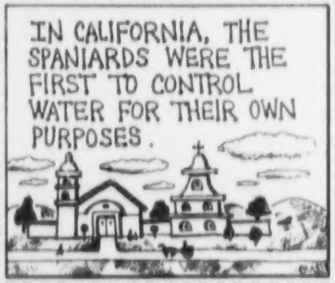
2. Teacher then asks how could these events become a timeline? (take all ideas)

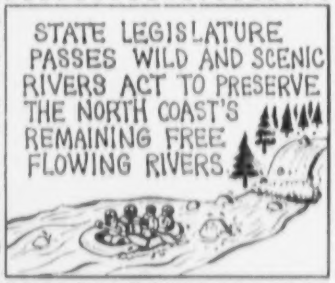
3. Teacher puts them in order, gluing them onto the adding machine tape, modeling what the students will do. Teacher can tape the sample to the board for student reference. Teacher reviews what a timeline is.

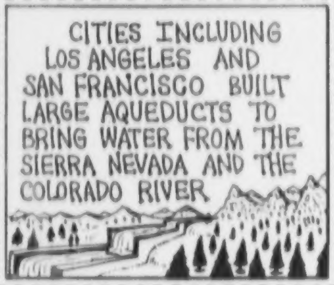
TIMELINE CARDS

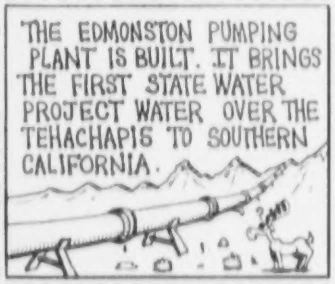

CALIFORNIA BECOMES THE 31ST STATE. MANY PEOPLE BEGIN MOVING TO CALIFORNIA.


THE DISCOVERY OF GOLD IN CALIFORNIA BROUGHT NEW DEMANDS FOR WATER.


IN CALIFORNIA, THE SPANIARDS WERE THE FIRST TO CONTROL WATER FOR THEIR OWN PURPOSES.


STATE LEGISLATURE PASSES WILD AND SCENIC RIVERS ACT TO PRESERVE THE NORTH COAST'S REMAINING FREE FLOWING RIVERS.


CITIES INCLUDING LOS ANGELES AND SAN FRANCISCO BUILT LARGE AQUEDUCTS TO BRING WATER FROM THE SIERRA NEVADA AND THE COLORADO RIVER.

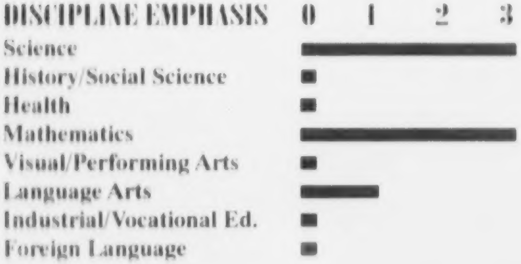

THE EDMONSTON PUMPING PLANT IS BUILT. IT BRINGS THE FIRST STATE WATER PROJECT WATER OVER THE TEHACHAPIS TO SOUTHERN CALIFORNIA.

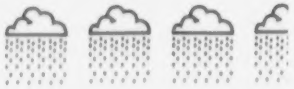
Living in Water

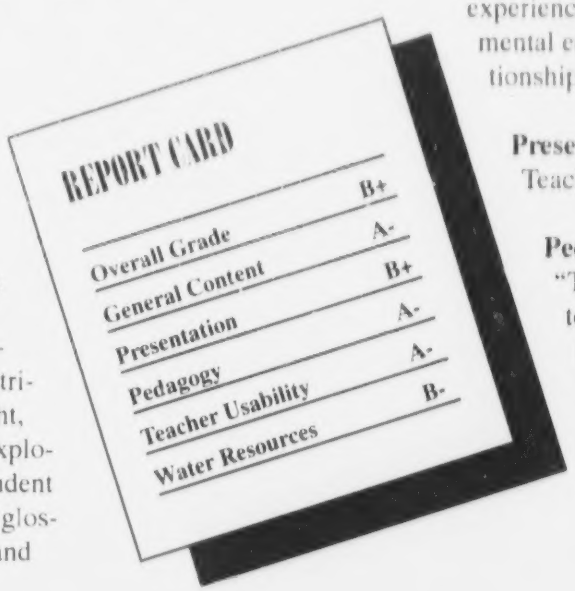
National Aquarium in Baltimore
Department of Education and Interpretation
Pier 3, 501 East Pratt Street
Baltimore, Maryland 21202
(410) 576-3887

$12.00. 1989. 314 pages.

"Living in Water" is a hands-on scientific study of water and aquatic environments. Thirty-six activities are organized in five sections, which explore the following topics: substances that dissolve in water and their effect on aquatic habitats; temperature changes; species distribution within aquatic habitats; sunlight, water, and aquatic food chains; and exploration and research. Reproducible student worksheets and information sheets, a glossary, and a section entitled "Recipes and Resources" are featured.







REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	A-
Water Resources	B-

COMMENTS

General Content

"An excellent approach... the curriculum builds upon a body of experiences in a logical sequence." "While not based on environmental education, the curriculum examines water in direct relationship to the organisms that live in aquatic habitats."

Presentation

Teacher outlines are separate from the lessons themselves.

Pedagogy

"This curriculum is designed with a constructivist approach to learning. Learning is guided and stimulated by questions."

"Good hands-on activities."

Teacher Usability

"Especially well suited for teachers with classroom aquariums." "Offers a wealth of resources."

Specific Content on Water Resources

"A great deal of information is on fish ecology, survival and adaptations, and water chemistry... not just water as a resource."

Water use and conflict, however, are not addressed.

ACTIVITY
1

THE DISAPPEARING ACT

WHAT HAPPENS WHEN DIFFERENT SUBSTANCES ARE ADDED TO WATER?

SCIENCE SKILLS:

- observing
- measuring
- organizing
- inferring
- predicting
- experimenting
- communicating

CONCEPTS:

- Many substances form a solution when mixed with water; some do not.
- Some substances go into solution faster than others.

MATH AND MECHANICAL SKILLS PRACTICED:

- bar graphing
- measuring volumes of fluids and powders

SAMPLE OBJECTIVES:

- Students will design and conduct an experiment to compare rates at which different substances dissolve in water.
- Students will compare different factors which affect rates at which some substances dissolve.
- Students will display data collected in a bar graph.

INTRODUCTION:

In this set of activities, students begin to explore the characteristics of water which relate to forming solutions and suspensions. Table salt and sugar are both among the substances which form a SOLUTION with water; that is, they DISSOLVE, mixing completely with the water and staying mixed. Some substances appear to mix completely, but do not go into solution. When they are allowed to sit undisturbed, they settle out. These compounds are said to form a SUSPENSION. Corn starch is a household compound that forms a suspension with water.

MATERIALS:

FOR CLASS:

- water
- table salt (use canning or kosher salt; see Recipes for discussion)
- granulated table sugar
- corn starch
- large clear glass jar
- package of a dark flavor of unsweetened Kool-aid

FOR EACH GROUP OF STUDENTS:

- 3 clear plastic glasses
- 3 plastic straws or stirrers
- a plastic teaspoon
- 3 pieces of tape or sticky labels
- a graduated measuring cup
- data sheets
- crayons or colored pencils

LESSON PLAN:

BEFORE CLASS:

Read the lesson and gather the materials.

DURING CLASS:

METHODS: As a demonstration, show the students a large clear glass jar of water and a package of unsweetened Kool-aid. Ask them to predict what will happen if you pour the Kool-aid into the water. Do they all agree? Pour the Kool-aid in and see what happens. It should sink and then begin to dissolve and spread (diffuse) through the water. Can the students suggest a way to speed up the process of dissolving? Stirring is one approach. A second would be to use hot water. Introduce the word SOLUTION for the mixture and the word DISSOLVE for the process of mixing completely.

What other things can the students name which they would find around the house that dissolve in water? List them. Show the students the table salt, sugar and corn starch. Ask them to predict whether each will go into solution. If they predict that these substances go into solution, could they design a test of their prediction? Secondly, could the students design a test to discover which dissolves fastest?

Here is a test they might try. Each group should label one clear plastic cup each as salt, sugar and corn starch. Fill each of three plastic cups with about the same volume of water at room temperature. Leave about 1 in of space at the top. Add the equal amounts of salt, sugar and corn starch to the cup of water labelled with that substance. For example, 2 heaping teaspoons to each. Observe what happens for two minutes. Then stir each cup by making a circle around the edge of the cup with the stirrer ten times. Was there a change? Repeat stirring ten times in each until one has completely disappeared or dissolved. Record how many time it was stirred. Continue stirring and observing the other two to find out which dissolves next fastest. Last?

In order for this to be a "fair test" each cup has to be treated exactly the same way. The only thing that can be different is the substance added to each. This is referred to as controlling variables. How you discuss this concept depends on the age of your children.

RESULTS:

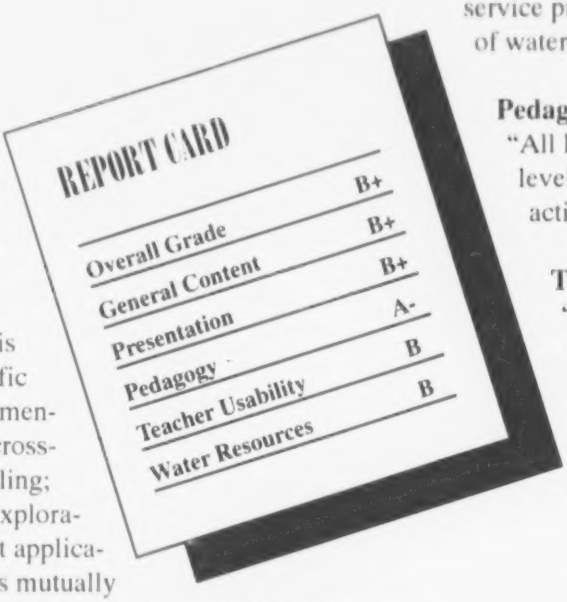
Each group should have three numbers which are the number of times each substance was stirred before it dissolved. How do you display such information? A bar graph would be a good way to compare three different things. Make the bar graph of the results. Now compare the results with

From Ridges to Rivers: Watershed Explorations

Science Experiences and Resources for
Informal Education Settings (SERIES)
University of California
c/o 4-H Watershed Project Coordinator
UCCE San Luis Obispo County
2156 Sierra Way, Suite C
San Luis Obispo, California 93401
(805) 781-5943

Materials included with training.
1994. 96 pages.

One of eight 4-H SERIES projects, "From Ridges to Rivers" offers teen-led science activities for use in informal education settings. The program is based upon four premises: that scientific thinking processes need to be developmentally appropriate and sequential; that cross-age teaching provides effective modelling; that each learning cycle moves from exploration to concept introduction to concept application; and that an apprentice structure is mutually beneficial for both the teen leader and younger student. Eight sessions explore watersheds; the interaction of gravity, water, and soil; and groundwater.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	A-
Teacher Usability	B
Water Resources	B

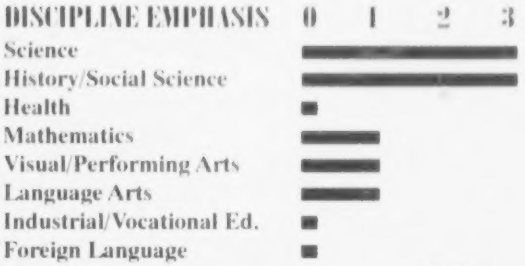
COMMENTS

General Content
"SERIES curriculum uses cross-age instruction and community service projects to make learning fun and relevant." An overview of watershed areas is provided.

Pedagogy
"All lessons are hands on activities at a very basic explanatory level." "Good science investigations and research-oriented activities."

Teacher Usability
"Teacher-friendly lesson format." "Really designed as a 4-H or after-school project."
"This would be best used where you have access to a creek or stream to explore and monitor the 'school backyard.'"

Specific Content on Water Resources "This is a highly recommended curriculum even though it doesn't cover everything under water resources."



SESSION SIX
AQUIFER IN A CUP

Review and Challenge Follow-up

Review

What do you rememberbest from the last session?

Challenge Follow-up

Did anyone try the Berlese Funnel? What did you find?

ACTIVITY A: Aquifer in a Cup

Objectives

- To promote understanding of how ground water is stored in aquifers underground.
- To examine how substances can travel with the water through the soil into the aquifer.

Time

30 minutes

Materials you will need

Old sheet or tarp
Clear plastic "Tumblers" - 6 - 9 oz size - 3 or 4 per person
Sand - approximately1 gallon
Gravel
  - approximately 1 gallon each of two different sizes (available at aquarium supply stores or landcsaping supply yards)
Pumps
  Plastic measuring syringes (6 cc) - found at farm, vet, or pharmacy supply stores
  1/8 inch drip tubing - found at hardware stores or aquarium supply stores
Well Casings:
  Masking tape
  Nylon Stocking
  Scissors
  Clear plastic straws
Spray bottles filled with water - one per person
Green Food Coloring in a squeeze bottle
Rags (To clean up spills)
Bucket - 2-5 gallon size

SERIES © 1994 by the Regents of the University of California Draft version 11/94

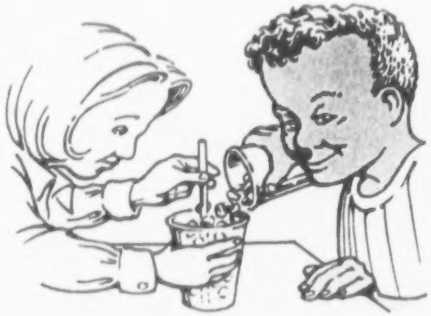
Action 1

1. **Show** the group the Pumps and Well Casings.

2. **Say** *Everyone please choose a pump, well casing, Aquifer Cup and an unmarked cup.*

I want to ask you for some predictions:
  ** Which will hold the most water before a pool of water forms at the surface: a cup of sand, a cup of small gravel, or a cup of large gravel?*
  ** From which cup - of sand, small gravel or large gravel - will I be able to pump the most water?*

Stand the Well Casing upright in the Aquifer Cup with the nylon filter pointed down.



Fill your Aquifer cups to the line with whichever you think will hold the most water: sand, small gravel or large gravel.

Observe what happens to the water and the soil as you add rain to your cups. Remember that you can see under ground by watching the sides and bottom of the cup. Take advantage of this opportunity!

Use the spray bottles to spray "rain" on your aquifer. Keep up the rain until pools form on the surface.

3. **Ask** *How much water did each of your aquifers hold?*

Action Continued...

SERIES © 1994 by the Regents of the University of California Draft version 11/94

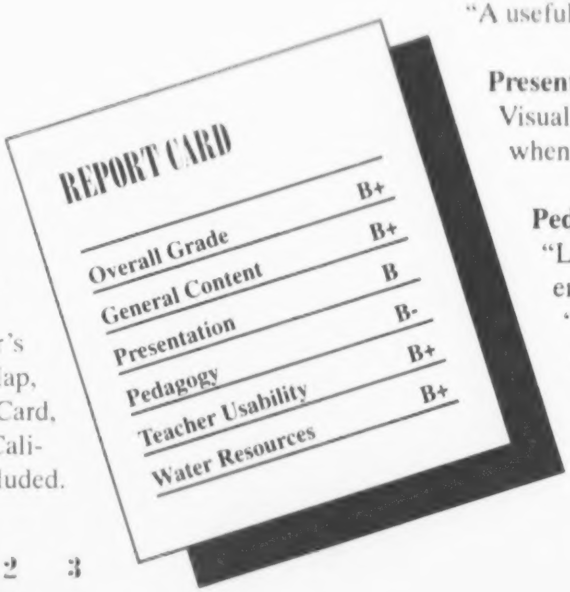
California Water Story

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

🌧 🌧 🌧 🌧

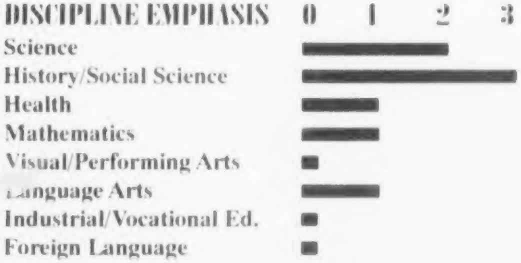
$20.00. 1995. Package format.

"The California Water Story" offers teacher information, data charts, and worksheets for six lessons on California geography, the hydrologic cycle, the history of water use in California, current water use patterns, water conservation, and water quality protection. The Teacher's Guide (24 pages), California Water Map, Hydrologic Cycle poster, Water Fact Card, Water Awareness stickers, and "The California Water Story" videotape are included.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B
Pedagogy	B-
Teacher Usability	B+
Water Resources	B+



COMMENTS

General Content

"Great lessons on geography using the large map and large posters." "A useful supplement to California water curricula."

Presentation

Visual support materials are well done and could be quite useful when studying the water cycle or California water issues.

Pedagogy

"Lessons appear to lack depth, although the "'Super Science' is useful for homework and small group activities." "Although this is not 'curricula,' it does a very good job addressing the controversy of water use in California."

Teacher Usability

"Great background resources... the best map and background compilation I've seen." "The California Water Map and Water Fact Card are available in Spanish."

Specific Content on Water Resources

"Directly related to California's geography and water systems."

Lesson 4: Water Use Today

Teacher Information

Objectives

Students will be able to:

1. Explain how and why water must be moved long distances to supply some cities.
2. List the benefits of dams and reservoirs.
3. Find the sources of water for their community and locate them on a map.
4. List a variety of uses for water.
5. Identify the major agricultural and urban areas in California.
6. Identify at least two major rivers in California.

Procedure

—There are four major activities in this lesson, two of which involve working directly with the "California Water Map." To prevent students bunching up around the map, we suggest you split your class into four groups and have them rotate through the activities, completing either one or two activities a day, depending on your schedule. Before you begin this lesson, contact your local water district and ask them to send you information about the sources of water for your community and the closest reservoir.

Introductory Discussion

Teacher says:

What do we use water for?

(Wait for a wide variety of answers: drinking, bathing, washing, watering plants, growing food, cleaning clothes, manufacturing things, recreation, preparing food, etc.)

We learned that most of the rainfall and most of California's rivers are in the north part of the state. Usually it is easy for most people and communities in northern California to get enough water for their needs. But California has a problem; most of its people live in southern California. Seventy-five percent of the rain falls in the north, but 75 percent of the people live in the south. These people need to conserve the water they have, but they need more than just the rain that falls in the southern part of California to meet their needs. How are all those people going to get the water they need?

(Move it there from some place that has more than enough water, like northern California.)

How do we move water from one place to another?

(In pipes, canals and aqueducts.)

Can we store water, save it to use later on?

(Yes, in reservoirs behind dams.)

California's leaders have had to study where the water is in California, how it is used and how to move it from one place to another. That is what we are going to study in the next group of activities.

Activity A: What is water used for?

Materials: A variety of magazines that can be cut up (like *Better Homes and Gardens*, farming magazines, hunting and fishing magazines, *Time* or *Newsweek*, *Family Circle*, etc.), scissors, glue or paste, paper.

—Have students cut out pictures of activities that use water or products that are made with water and paste them into a collage. Spot check them as they work and ask them to explain why they have chosen a particular picture.

Activity B: Water for Big Cities

Materials: "California Water Map," blank California outline map (Map 2), colored pens, pencils or crayons.

—Give each student in the group a blank California map and ask them to draw in the major water sources for the cities in the instructions. Point out the general location of each city on the "California Water Map," but let the students hunt for the aqueducts.

Worksheet: Lesson 4
Using California's Water

I. Fill in the names of the numbered water bodies on your map next to the numbers below:

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________
6. ____________
7. ____________
8. ____________
9. ____________
10. ____________
11. ____________
12. ____________
13. ____________

II. Rivers flow downhill until they run into another river, the ocean, or an inland low area like the Salton Sea.

Which direction (north, south, east or west) do the following rivers or aqueducts flow?

3. ____________
7. ____________
8. ____________
13. ____________

(This is tricky.)

III. More questions:

1. Both #3 and #6 flow into a low marshy area that empties into San Francisco Bay. This is called the: ____________
2. Which river is a "Wild and Scenic" river? ____________
3. What two aqueducts carry water from northern California to southern California? ____________
4. The Coachella Valley is a big agricultural area close to the Salton Sea. Some of its water comes from a large ground water basin. What canal supplies additional water? ____________
5. Land with lots of rivers flowing through it is usually good farm land. Where do you think California's best farm land is? ____________

Answers

I. 1. Klamath River
2. Lake Shasta
3. Sacramento River
4. Lake Oroville
5. Lake Tahoe
6. Sacramento-San Joaquin Delta
7. San Joaquin River
8. California Aqueduct
9. Mono Lake
10. Los Angeles Aqueducts
11. Colorado River Aqueduct
12. Salton Sea
13. All-American Canal

II. 3. South
7. North
8. South
13. West

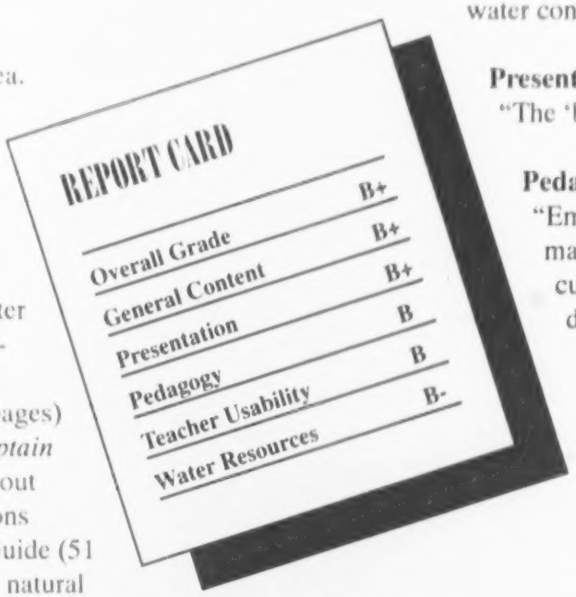
III. 1. Sacramento-San Joaquin Delta
2. #1—Klamath River
3. #8—California Aqueduct and #10—Los Angeles Aqueducts
4. #13—the All-American Canal which is supplied by the Colorado River
5. The Central Valley

The Official Captain Hydro Water Conservation Workbook

Public Information Office
East Bay Municipal Utility District (EBMUD)
P.O. Box 24055
Oakland, California 94623-1055
(510) 287-0138

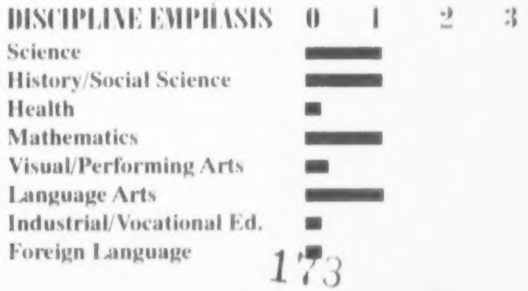
No charge within EBMUD service area. $2.00 per teacher guide and $.50 per student workbook outside EBMUD service area (quantity discounts are available). 1992. Bilingual.

A component of Project WATER (Water Awareness through Education and Research), "The Official Captain Hydro Water Conservation Workbook" (39 pages) features the comic book character *Captain Hydro* presenting basic knowledge about water, as well as problems and solutions related to water use. The Teacher's Guide (51 pages) offers 15 activities on both the natural and built water cycle, uses of water, and water conservation and management. Reproducible worksheets, a glossary, and a bibliography are provided.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B
Teacher Usability	B
Water Resources	B-



COMMENTS

General Content
"A catchy workbook that could quickly focus student attention on water conservation."

Presentation
"The 'built water cycle' is never defined."

Pedagogy
"Emphasis appears to be on problem-solving, decision-making, and attitude formation." "This is not a complete curriculum, but it would, no doubt, be appealing to students."

Teacher Usability
"This material lacks background information for teachers and the time constraints are vague." "Useful water conservation surveys are provided." "It's helpful that the students booklet is available in Spanish."

Specific Content on Water Resources
"Addresses competition for use of water in California."

The Water Cycles

Natural Water Cycle

DESCRIPTION: Students discuss the natural water cycle and observe a simulated demonstration of it.

OBJECTIVE: To understand how the natural water cycle functions; to observe the effects of temperature on water; and to become aware of the behavior of water that makes it available for human use.

TIME: 2 class periods

MATERIALS: heat source (hot plate or canned heat), heavy glass tumbler, glass flask, water, saucepan with lid, tablespoon of sand

PREPARATION: Students read pages 2 - 6 of **Captain Hydro**. Q. What are some of the things Marvin learned about water? Refer students back to the diagram of the Water Cycle on page 2.

FRAMEWORK REFERENCE: Earth Sciences, C-1 The Water Cycle; Climate, Weather. Grades 3 through 6. Processes: Observing, Relating, Inferring.

ACTIVITY

Step 1

Q. Why is this movement of water called a cycle?
It repeats itself over and over.

Q. How important is heat from the sun in the cycle?
Without it, nothing would happen.

Q. Plants, animals and human beings do not appear in the diagram. What part do they play in the cycle?
All release water into the atmosphere. All use it.

Step 2 Teacher Demonstration

Heat some water until it is near the boiling point (steaming). Pour it into a tall, heavy glass tumbler until the glass is half full. (Use an oven mitt so that you don't burn yourself). Rotate the tumbler so as to moisten the sides clear to the top. Place some very cold water in the glass flask and set it on top of the tumbler as shown.

Step 3 Direct students to worksheet on page 12.

Q. Which parts of the experiment represent water as found in: rain? lakes or rivers? clouds?
(see answers on worksheet)

Q. What heats water in rivers or lakes?
The sun.

Q. Where in the experiment did the following take place? evaporation? condensation? precipitation?
(see answers on worksheet)

Step 4 Teacher Demonstration

Place a saucepan half-filled with water on the hot plate or on a tripod with a burner beneath. Add a tablespoon full of sand to the water. Let the water come to a boil. Place a tight lid on the saucepan. After 3 minutes remove the lid and show it to the class.

Q. Why is the lid not sandy? Does this tell you anything about rainwater not being salty, even though it often starts as ocean water?
Salt and sand are heavier than water and are left behind when water evaporates.

Q. Besides oceans, lakes and rivers, are there any other sources of water that become rain when they evaporate?
Glaciers, snow and transpiration. Transpiration is the process by which all plants give off to the atmosphere the water they do not use coming from the ground. A single birch tree can give off 60 to 80 gallons of water to the air on one warm day. The atmosphere itself always carries huge amounts of water waiting to be condensed and fall as rain.

Step 5 Review Exercise (oral or written, as teacher desires)

1. Explain the natural water cycle.
2. Define: evaporation, condensation, precipitation, transpiration.
3. Why do some parts of the country get large amounts of rain while other parts are almost deserts?
   Nearness to sources of water, mountains, wind and other factors influence where rain will fall.
4. What part does wind play in governing the amount of rain a place gets? mountains?
   Wind must be present to transport rainfall, mountains impede the movement of rainstorms.
5. Are the parts of the world where it rains heaviest very hot or very cold places? Can you tell why?
   Usually very hot (Hawaii, the tropics) with much vegetation. Abundant moisture and heat are available.

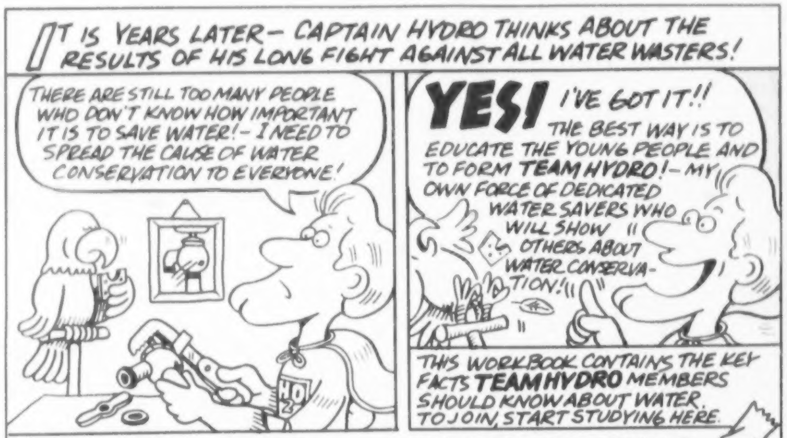
Follow-up:

A film or filmstrip on the Water Cycle would be appropriate here.

References:

Water, Time-Life Books, Life Science Library pp. 32-41.
The Hydrologic Cycle, U. S. Department of Interior (pamphlet).
Water Conservation and the Water Cycle, U. S. Department of Agriculture Information Bulletin No. 326.

175


IT IS YEARS LATER— CAPTAIN HYDRO THINKS ABOUT THE RESULTS OF HIS LONG FIGHT AGAINST ALL WATER WASTERS!
THERE ARE STILL TOO MANY PEOPLE WHO DON'T KNOW HOW IMPORTANT IT IS TO SAVE WATER!— I NEED TO SPREAD THE CAUSE OF WATER CONSERVATION TO EVERYONE!
YES! I'VE GOT IT!! THE BEST WAY IS TO EDUCATE THE YOUNG PEOPLE AND TO FORM TEAM HYDRO!— MY OWN FORCE OF DEDICATED WATER SAVERS WHO WILL SHOW OTHERS ABOUT WATER CONSERVATION!
THIS WORKBOOK CONTAINS THE KEY FACTS TEAM HYDRO MEMBERS SHOULD KNOW ABOUT WATER. TO JOIN, START STUDYING HERE.
H2O

THE NATURAL WATER CYCLE

Where does water come from? All water comes from the glaciers, oceans, lakes and rivers that exist on earth. That water rises into the atmosphere as a vapor by **evaporation**. Plants and animals transfer water from their bodies into the atmosphere as vapor by **transpiration**. The water vapor changes back to water droplets by **condensation** when it is cooled at higher altitudes. Droplets then form clouds. When the clouds become too heavy with moisture, gravity causes the moisture to fall as **precipitation:** rain, snow, sleet or hail. The cycle repeats itself over and over.

DEMONSTRATION REPORT

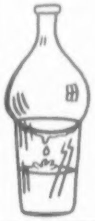
Define the terms given below. Note where each process occurs in the demonstration.

Evaporation

Condensation

Precipitation

Transpiration



Place each of the following words in the appropriate space to represent water as found in nature: **lake, cloud, rain**

Describe briefly what happens in the demonstration.

176

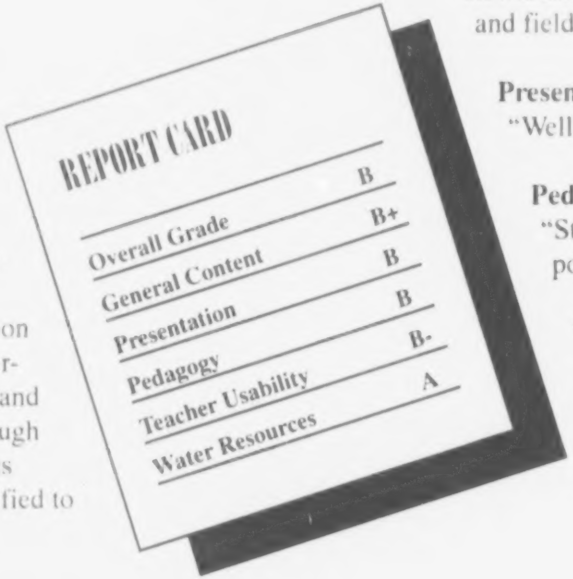
Active Watershed Education Curriculum Guide

Southern Rhode Island Conservation District
P.O. Box 1522
Kingston, Rhode Island 02881
(401) 874-5198

$40.00. 1994. 274 pages.

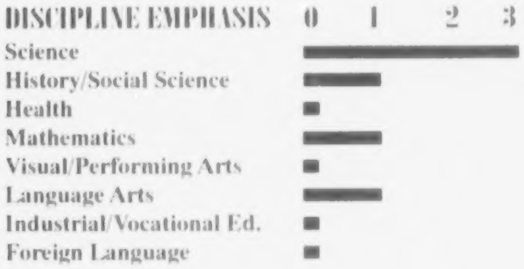
The "Active Watershed Education Curriculum Guide" revolves around eight classroom units, three field trips, and one culminating activity simulating a public hearing. The classroom units explore watersheds, wetland ecology, water and soil resources, effects of land use on watersheds, cultural resources in watersheds, water quality issues, and point and non-point sources of pollution. Although regional (Southern Rhode Island) in its approach, the curriculum can be modified to work elsewhere.

🌧 🌧 🌧



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B
Teacher Usability	B-
Water Resources	A



COMMENTS

General Content
"This curriculum possess a genuine message for environmental stewardship. It is well balanced between class research activities and field trips." "It studies the entire watershed."

Presentation
"Well organized - nice overheads!" "Needs more graphics."

Pedagogy
"Students learn to identify, analyze, and share different points of view and values relative to a decision."

Teacher Usability
"Not as teacher-friendly as it could be - too much to wade through to get the activities."
"Background portion is fairly extensive."

Specific Content on Water Resources
"Quite regional to Southern Rhode Island."

ACTIVITY I: WHO DIRTIED THE WATER?

OBJECTIVE: Students will learn about current sources of water pollution, how they represent water quality issues, and ways that these sources of pollution are being controlled.

METHOD: Students will actively participate in a visual representation of a body of water that receives various sources of pollution. Students will discuss what problems underlie the sources of pollution represented and how alternatives can be found to help reduce these sources.

MATERIALS: labeled film canisters filled with various materials, which represent different pollutants (see chart below), a large, clear, wide mouth glass jar, "pollution clean-up tools" such as sponge, paper towels, baking soda, sieve, coffee filters, spoon, pH paper.

BACKGROUND INFORMATION:

1. Substances get into our water supply in many different ways. Water pollution is classified into two main categories: point and non-point source pollution. Point sources originate from a specific point on the landscape such as a discharge pipe from a factory or sewage treatment plant. Non-point sources originate over a widespread area of the landscape, and thus it is difficult to determine exactly where the pollution comes from.

2. See discussion chart below for more information.

3. The effect of a contaminant depends on the concentration of the contaminant, the volume of water in the receiving water body, and the rate of flow of water through the water body. Thus contaminants entering a river may travel much farther and become more widespread than those entering a lake with a limited outflow.

PROCEDURE:

1. Ask students: what is an issue? Emphasize that an issue is a problem caused by differing opinions based on different values that result in different ways of doing things.

Who Dirtied The Water?

Note: after each paragraph, after a substance is added to the jar of water, ask the following questions to the class.
Would you drink from the lake if it had a drinking water treatment plant?
Would you swim in the lake? Would you boat on the lake?
Note also that this is merely our version of this story; feel free to modify it to fit your particular needs.

Once there was a large lake surrounded by acres of green forests and brushland. It was a clear lake, and the only pollution the lake received was natural, from **TREES**. This was not a problem since the lake was not being used for drinking water.

In a little while, though, the **1st HOME OWNER** moved in. They had a septic system, but did not use it wisely. The **1st HOME OWNER** used toxic household cleaners and dumped them down the drain. They ended up in the lake after passing through the septic system.

Not too long after that, a **2nd HOME OWNER** moved in, close by to the first one. They also had a septic system for their house. A few years went by and they did not keep their septic system maintained. The septic tank began to leak, and this also ended up in the lake.

At almost the same time, a **3rd HOME OWNER** moved in nest to the second one. They had a large green lawn, which the homeowner was quite proud of. Unfortunately, they used too much fertilizer and watered too often. A lot of the fertilizer washed down and away from the grass roots and eventually also ended up in the lake.

Now that a small neighborhood was around the lake, people began to visit its beach. There weren't too many **BEACH GOERS** but they did not pick up after themselves. They left litter on the shores and some of the litter ended up in the water of the lake, too.

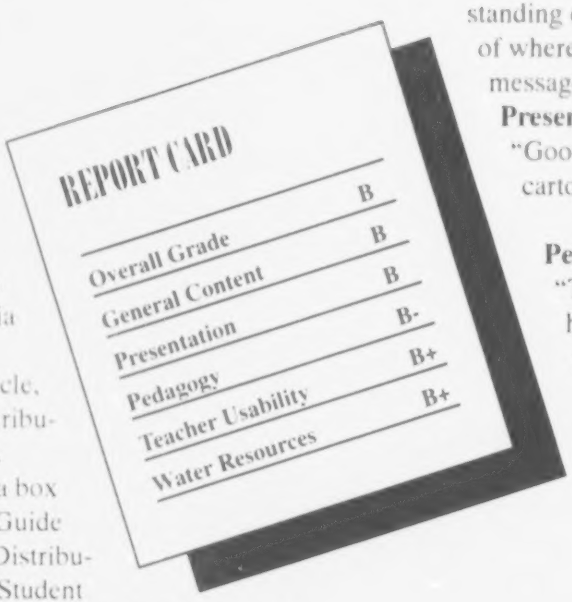
There was a lot of flat, stone free land around the lake, and 2 farms moved into the area. The **1st FARMER** used poor erosion control of his cropland, and sediment from the farm's fields made its way to the lake, clouding it up. The **2nd FARMER** that moved in made an orchard of apples, and they required the use of pesticides to keep insects from eating all the apples.

Admiral Splash

Metropolitan Water District of
Southern California
Education Programs
P.O. Box 54153
Los Angeles, California 90054-0153
(213) 217-6398

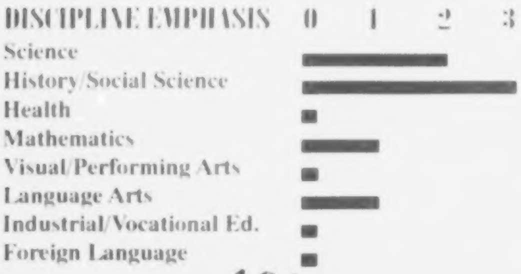
$25.00. Materials are free in MWD Southern California service area. 1993. Kit format. Bilingual student materials.

"Admiral Splash" introduces students to issues regarding Southern California water supplies. Activities revolve around six content areas: the water cycle, water history, water supply, water distribution, water use, and wise use of water. Classroom materials are packaged in a box and include a spiral bound Teacher's Guide (47 pages), video, Water Supply and Distribution poster, and classroom sets of the Student Booklet, Home Water Use Survey, Admiral Splash stickers, and pre/post tests.



REPORT CARD

Overall Grade	B
General Content	B
Presentation	B
Pedagogy	B-
Teacher Usability	B+
Water Resources	B+



COMMENTS

General Content

"This revised edition of 'Admiral Splash' helps develop an understanding of water in California." "It provides a clear understanding of where Los Angeles water comes from - with a conservation message."

Presentation

"Good maps!" "High student interest will be generated with the cartoon format without being too silly for older children."

Pedagogy

"Too much reliance on workbook activities and not enough hands-on application." "Needs more depth and greater emphasis on higher level thinking skills."

Teacher Usability

"Almost all of the materials are available in Spanish." "A nice list of children's literature books on water." "Home Water Use Survey is excellent." "This could be easily integrated into the fourth grade curriculum."

Specific Content on Water Resources

"Very specific in its focus ... does not address the larger issues of economic, political, and ecological impact of the California Aqueduct."

LESSON 4: HISTORY OF WATER SUPPLY

Materials:
- Student booklets, pages 5-8
- *Water Supply and Distribution* poster

Vocabulary:
- **dam**—a structure that is built to hold back the flow of water
- **pueblo**—Spanish word for village
- **zanja**—Spanish word for ditch

Procedures:

A. **Have students read about and discuss California's water history**

- Have students open their booklets to page 5
- Ask students to remember Admiral Splash's trip back in history in the video. Remind them that water has not always been readily available in Southern California; it has taken a lot of hard work to supply us with the water we need
- Have individual students read the text under each picture on pages 5 and 7. *(See Teacher Background Information on page 33 for more information on each aqueduct.)*
- As each aqueduct and the cities and places associated with it are mentioned in the text, have students look at the map on page 6 of their booklets to locate them

B. **Display and discuss the poster**

- Display the *Water Supply and Distribution* poster on a bulletin board. Explain that this poster shows how water is supplied and distributed in Southern California
- Ask students to use the poster to help answer the following questions about water supply in Southern California. Have individual students point out various places on the poster as they are mentioned

1. **Where do people in Southern California get their water?**
   (About 2/3 of the water comes from aqueducts and about 1/3 comes from groundwater.)

2. **Why did we build aqueducts to bring water into Southern California?**
   (Northern California gets lots of rain and snow, but Southern California gets very little rain. In California, most of the people live in the south, and the population is increasing all the time.)

3. **According to the Admiral Splash bar graph on the poster, about how many people lived in California in 1950, 1960, 1970, 1980, and 1990?**
   (In 1950, about 11 million people lived in California; in 1960, about 16 million; in 1970, about 20 million; in 1980, about 24 million; and in 1990, about 30 million.)

HISTORY OF WATER SUPPLY IN SOUTHERN CALIFORNIA

4. **How do you think the increase in population affected our water supply?**
   (California has the same amount of water but a lot more people, so we've had to be more careful how much water we use. Our water supply per person is less than it used to be.)

5. **Which aqueduct was built first?**
   (The Los Angeles Aqueduct was built first.)

6. **Where does the aqueduct begin?**
   (It begins in the Owens Valley.)

7. **What city does this aqueduct supply?**
   (It supplies the city of Los Angeles with water.)

8. **Which aqueduct brings water from east of Los Angeles?**
   (The Colorado River Aqueduct starts east of Los Angeles.)

9. **Where does the water in this aqueduct come from?**
   (The water comes from the Colorado River.)

10. **Which aqueduct was built last?**
    (The California Aqueduct was built last.)

11. **What city does the California Aqueduct start near?**
    (It starts near Sacramento, the capital of California.)

12. **The California Aqueduct splits into two branches, the east branch and the west branch. Where does each branch go?**
    (The west branch goes to Los Angeles County. The east branch goes to Riverside County.)

    *(**Note**: The west branch serves primarily Los Angeles County, Orange County, and parts of Ventura County. The terminal reservoir for the west branch is Castaic Lake in Los Angeles County. The east branch serves primarily San Diego County and parts of Riverside and San Bernardino Counties. The terminal reservoir for the east branch is Lake Perris in Riverside County.)*

13. **Where is your city on the map?**
    (If your city is not on the poster, have students locate about where it would be and write it on the map.)

HISTORY OF WATER SUPPLY IN SOUTHERN CALIFORNIA
POPULATION
YEAR
WATER USE
San Francisco
Owens Valley
CALIFORNIA AQUEDUCT
San Bernardino
Los Angeles
San Diego
PACIFIC OCEAN

HISTORY OF WATER SUPPLY IN SOUTHERN CALIFORNIA (Continued)

BEST COPY AVAILABLE

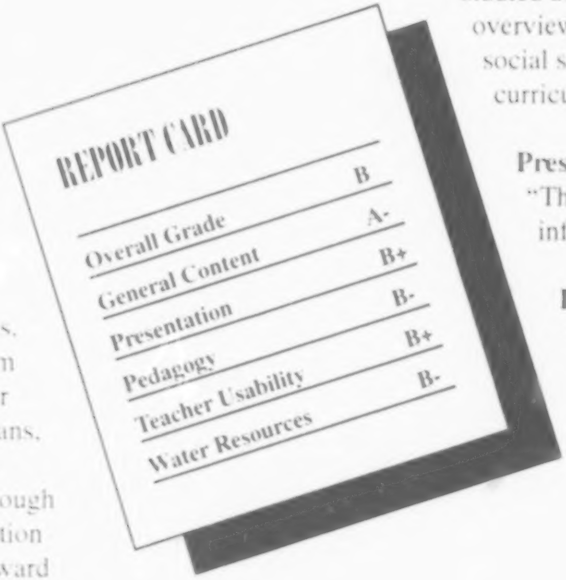
Waterways

Metropolitan Water District of
Southern California
Education Programs
P.O.Box 54153
Los Angeles, California 90054-0153
(213) 217-6398

$20.00. Materials are free in MWD Southern California service area. 1995. 48 pages.

"Waterways" serves as a fifth-grade supplemental curriculum in history and social science, using student readings, maps, and hands-on activities. Arranged in three sections, the program explores the influence and use of water among Pre-Columbian Native Americans, early Colonial settlers, and nineteenth century settlers who moved west. Through language arts, music, and art, each section emphasizes the use of and attitudes toward water, geographical concepts, and water problems encountered in each particular time period.

☁ ☁ ☁



REPORT CARD

Overall Grade	B
General Content	A-
Presentation	B+
Pedagogy	B-
Teacher Usability	B+
Water Resources	B-

COMMENTS

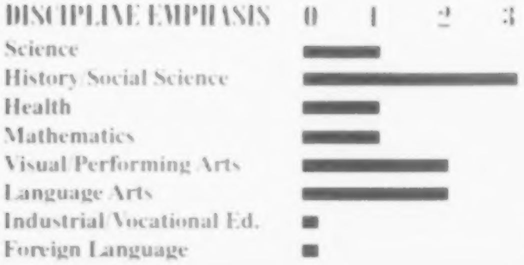
General Content
This is an excellent supplemental curriculum about water issues studied across the disciplines. "This gives a good, visual historical overview of water use. It would work well with a fifth grade social studies book and a good science/environmental education curriculum."

Presentation
"The student 'newspaper' is bright and colorful ... lots of information ... lots of reading."

Pedagogy
"Waterways" employs a diversity of instructional strategies. "Objectives are clearly stated."

Teacher Usability
Background material accompanies every lesson. "The best feature is the student booklet." "This is an excellent, focused set of materials for the fifth grade teacher who wants to integrate history, map study, and literature with water studies."

Specific Content on Water Resources
"The 'science of water' is not presented, nor are current water issues and conflicts."



WATER WAYS
TEACHER GUIDE
THE PEOPLE BEFORE COLUMBUS

Introduction

Purpose of Pre-Columbian emphasis

W[illegible]

Objectives

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

Background Information

Prehistoric: Pre-Columbian

[illegible]

"People" and "Native Americans"

[illegible]

Lesson Plan — Page 2

ARTIFACTS TELL THE STORIES OF ANCIENT WAYS

1. [illegible] **archaeologist, gourd, artifacts, *Pre-Columbian Native Americans*.**
2. [illegible]
3. **Activity—Join the Dig.** [illegible]

[illegible]

Lesson Plan — Page 2

PEOPLE EVERYWHERE COMMUNICATE THROUGH ART

1. [illegible] ***pictographs, petroglyphs***
2. [illegible]
3. [illegible]
4. **Activity—One Picture is Worth a 1000 Words.** [illegible]

Lesson Plan — Page 3

THE LEGEND OF "RAVEN-WHO SETS-THINGS-RIGHT"

Background Information. [illegible]

1. [illegible] ***legend, myth, Chinook*** [illegible] ***devised***
2. [illegible]
3. **Activity—Map Study.** [illegible]
4. **Activity—Write a Legend About Water.** [illegible]
5. **Activity—Story Circle.** [illegible]

[illegible]

Lesson Plan — Page 2

THE GREATEST RIVER OF ALL

Background Information. [illegible]

1. [illegible] ***Winnebago, fertile, silt, tributary, Lake Superior, Ohio River, "Messi Sippi"*** [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. **Activity—Map Study.** [illegible]

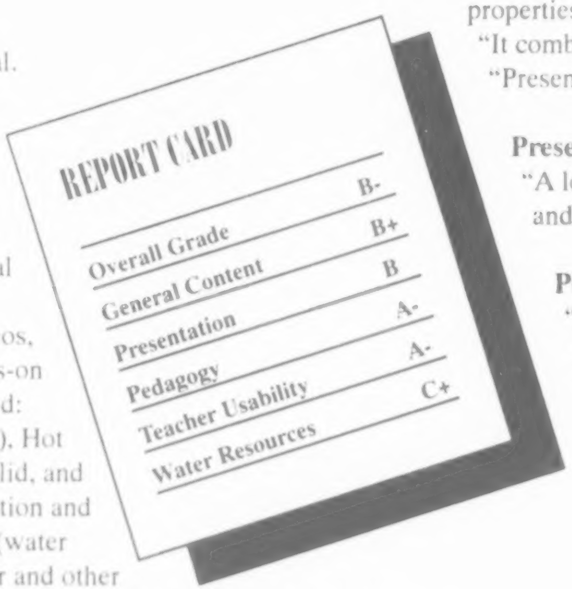
GRADES 4-6

FOSS Water Module

Britannica Science System
Encyclopaedia Britannica Educational Corporation
310 South Michigan Avenue
Chicago, Illinois 60604
(800) 554-9862

$469.00. 1993. Box format. Bilingual.

Created by Lawrence Hall of Science, the "FOSS (Full Option Science System) Water Module" consists of 14 leaflets packaged in a Teacher's Guide (binder format), spiral bound index and English/Spanish glossaries, laboratory equipment, videos, and multimedia materials. Four hands-on and multisensory activities are featured: The Water Works (properties of water), Hot Water, Cold Water (water in liquid, solid, and gaseous states), Water Vapor (evaporation and condensation), and Testing the Water (water quality and interactions between water and other substances). The "FOSS Water Module" was evaluated without its laboratory component for the purpose of the compendium.



REPORT CARD

Overall Grade	B-
General Content	B+
Presentation	B
Pedagogy	A-
Teacher Usability	A-
Water Resources	C+

🌧 🌧 🌧

COMMENTS

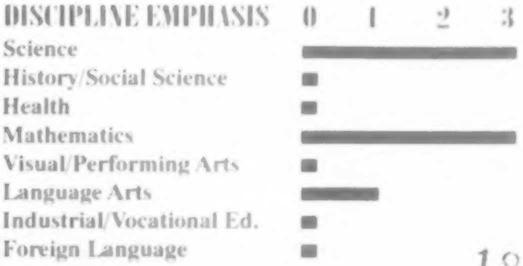
General Content
"FOSS provides a hands-on science approach to exploring the properties of water."
"It combines the content of science with the process of science."
"Presents valuable water science activities."

Presentation
"A lot of material for very little curricular content." "Fancy and well organized."

Pedagogy
"Good science ... but not environmental education."
"Stewardship is not addressed, but scientific literacy is."
"Exemplary active learning!" "Excellent authentic assessment!"

Teacher Usability
"The FOSS kit is expensive ... to put your own together is time-consuming." "Index and glossary are very helpful."

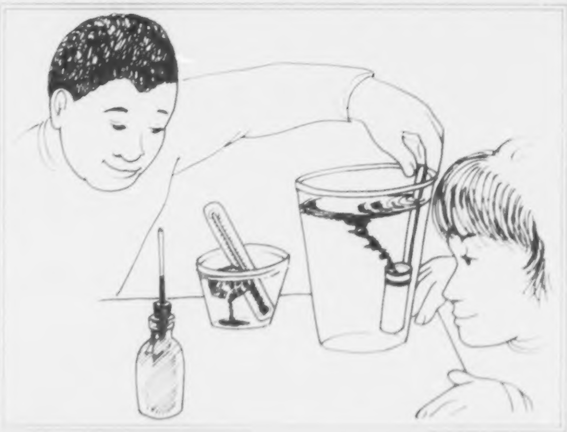
Specific Content on Water Resources
Only the physical and chemical properties of water are addressed.



WATER MODULE Grades 3-4

HOT WATER, COLD WATER

ACTIVITY 2



STRAND

Earth Science

SCIENCE CONCEPTS

Change
Liquid
Property
Solid
Temperature

SCIENCE THINKING PROCESSES

Observing
Communicating
Comparing
Organizing

INTERDISCIPLINARY ACTIVITIES

Language
Social studies

PURPOSE

In *Hot Water, Cold Water* students will

- Construct a thermometer to observe that water expands as it gets warm and contracts as it cools.
- Observe and describe the interactions between water of different temperatures.
- Compare properties of two states of water—solid (ice) and liquid.
- Learn concepts that will contribute to understanding of the following themes: **Pattern**, **Interaction**, and **Change**.

THEMES

Pattern
Interaction
Change

OVERVIEW

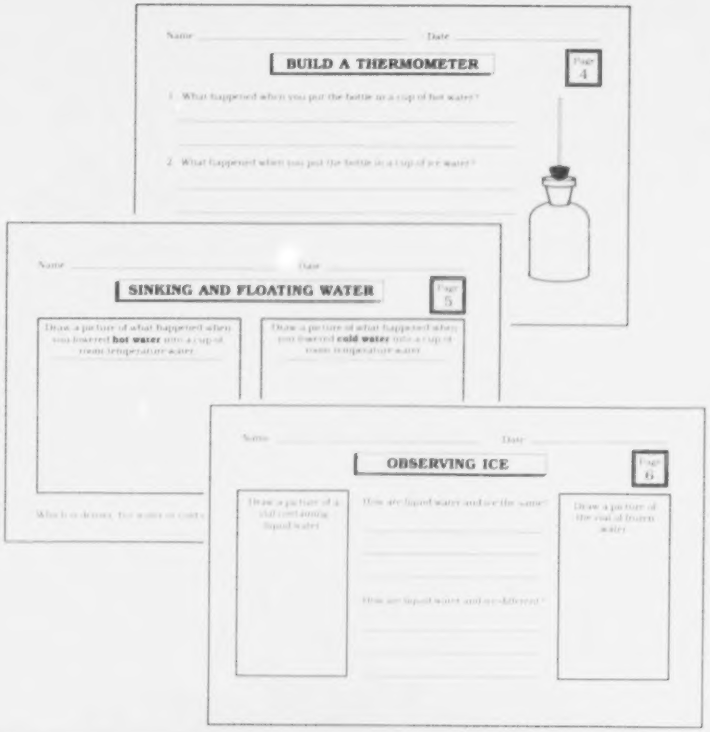
In *Hot Water, Cold Water* students observe the properties of water as it is heated, cooled, and frozen. They make a thermometer from a bottle filled with water, a rubber stopper, and a straw. They discover that, as water gets warmer, it expands, and, as water cools, it contracts. Students are introduced to density and use an operational definition to determine if materials are denser or less dense than room-temperature water. They lower vials of warm water and cold water into containers of room-temperature water and discover that warm water floats and cold water sinks. Finally, they observe and compare the properties of liquid and solid water to discover that ice is less dense than liquid water and that liquid water expands when it freezes.

GETTING READY

8. **Set Up a Materials Station.** This activity is written for use with collaborative groups. Plan to organize the materials for the activity in a convenient location where the GETTERs can get the materials needed by the groups.

9. **Copy Student Sheets.** If you haven't already assembled the entire *Water Log*, make copies of the three half-sheets, pages 4-6, for each student. Allow time before or after cleanup for students to complete these sheets.

STUDENT SHEETS



Name Date

BUILD A THERMOMETER

Page 4

1. What happened when you put the bottle in a cup of hot water?

2. What happened when you put the bottle in a cup of ice water?

Name Date

SINKING AND FLOATING WATER

Page 5

Draw a picture of what happened when you lowered **hot water** into a cup of room temperature water.

Draw a picture of what happened when you lowered **cold water** into a cup of room temperature water.

Which is denser, hot water or cold

Name Date

OBSERVING ICE

Page 6

Draw a picture of a vial containing liquid water

How are liquid water and ice the same?

How are liquid water and ice different?

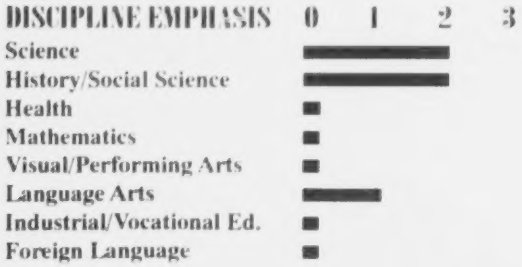
Draw a picture of the vial of frozen water

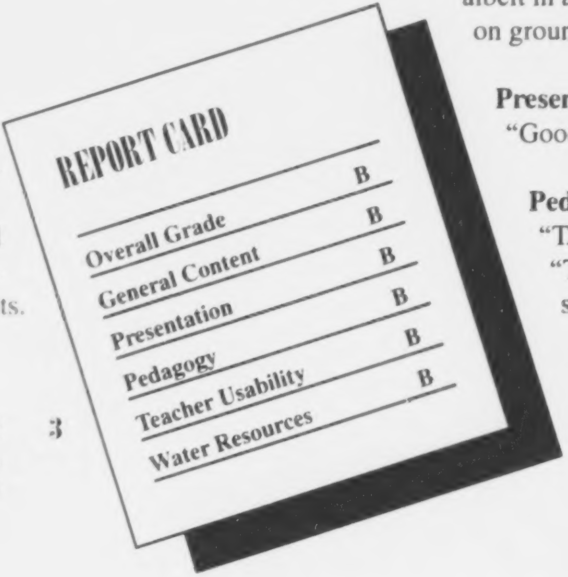
Teaching Aquifer Protection Notebook

Clemson University Cooperative Extension Service
Bulletin Room, #82
P & A Building
Clemson, South Carolina 29634
(864) 656-3261

$7.50. 1993. 80 pages.

The "Teaching Aquifer Protection" (TAP) notebook explores water concepts, groundwater, sources of contamination, and water recycling and conservation. Six activities are accompanied by tests, glossary, and worksheets. Teacher training is required.





REPORT CARD

Overall Grade	B
General Content	B
Presentation	B
Pedagogy	B
Teacher Usability	B
Water Resources	B

COMMENTS

General Content
"Here the fundamentals of water quality protection are taught, albeit in a cursory way." "This offers some hands-on activities on groundwater (non-point source) contamination."

Presentation
"Good illustrations." "Text font is difficult to read."

Pedagogy
"TAP needs more hands-on and constructivist lessons." "The lesson methodology is mainly lecture and demonstration."

Teacher Usability
Training is required for use of the notebook. "The historical use of water is regional to South Carolina. Most other sections are adaptable."

Specific Content on Water Resources
Primarily groundwater conservation and prevention of contamination. Does not focus on the sociopolitical side of water resources and pollution control.

Lesson 3

GROUND WATER CYCLE

Content:
Ground water is water found beneath the surface of the earth and eventually re-emerges as surface water.

Main Objectives

Youth will gain an understanding of the nature of groundwater and an appreciation for why it is so essential to protect our groundwater from contamination. Youth will gain an understanding of how water moves through the soil, how it is stored in the ground, and provides a source of water to our wells and springs.

Learning Objectives

1. Youth will understand the nature of groundwater.
   BSAP Science Objective CN2-A2: "The student can comprehend and apply properties of the earth's water."
2. Youth will understand how dependent we are on groundwater for our water supply.
   BSAP Science Objective CN1-B1 and CN1-B2: "The student can comprehend and apply the following: - Living things are interdependent with their environment in which they live (CN1-B1). - Living things interact with each other and the environment in which they live (CN1-B2)."
3. Youth will be able to talk about why groundwater is vulnerable to pollution.
   BSAP Science Objective ST2-A: "The student can comprehend, apply and analyze the relationships of science/technology to self, society and the environment."
   Learning Activities - Groundwater model - Soil as a filter

Learning Activities

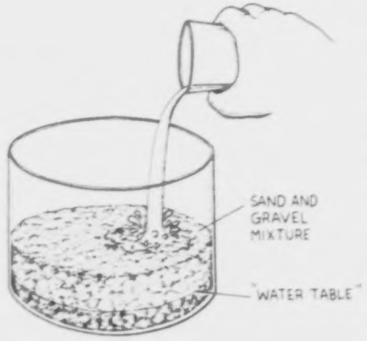
1. Groundwater model
2. Soil as a filter

LEARNING ACTIVITIES

ACTIVITY 1: GROUNDWATER MODEL

Materials Needed

1. Large glass jar
2. Sand and gravel mixture
3. Water



Directions

1. Pour the sand and gravel mixture into the jar.

2. Add water until students can see the level of the water through the jar. Explain that this is the water table, the upper limit of groundwater. Below the level of the water table the pores between the sand and gravel are filled with water. This region is called groundwater.

ACTIVITY 2: SOIL AS A FILTER

Have students form small groups to complete the "Soil as a Filter Student Worksheet." Each group will need a supply of all of the materials listed below.

Materials Needed

1. 6 jars, 4 with lids
2. filter paper
3. measuring teaspoons
4. potting soil
5. sand
6. 2 funnels
7. sugar
8. vegetable oil
9. food coloring
10. water

Expected Results

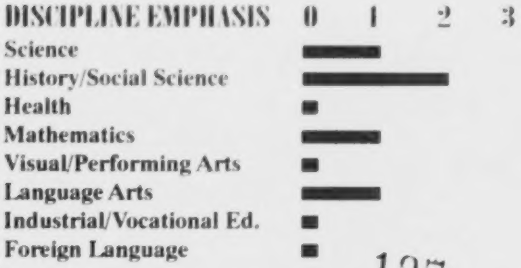
Soil should be more effective than sand in filtering out the substances. This is because soil has smaller particles, making it easier for substances to adsorb onto soil. Vegetable oil should be filtered out by the soil particles but sugar and food coloring should pass through the soil.

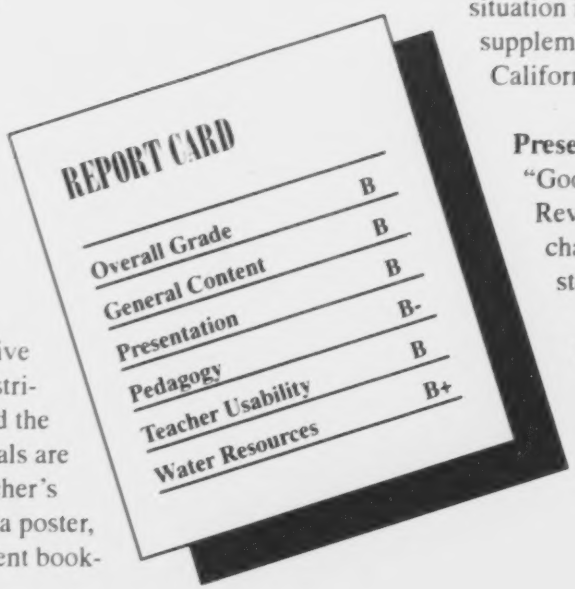
California Smith, Water Investigator

Metropolitan Water District of
Southern California
Education Programs
P.O, Box 54153
Los Angeles, California 90054-0153
(213) 217-6398

$25.00. Materials are free in MWD Southern California service area. 1993. Kit format. Bilingual student materials.

"California Smith, Water Investigator" introduces students to issues regarding Southern California water supplies. Activities revolve around five content areas: water supply, water distribution, water issues, future water, and the wise use of water. Classroom materials are packaged in a box and include a Teacher's Guide (58 pages), Water in California poster, video, and classroom sets of the student booklet, home leaflets, bookmarks, and pre/post tests.





REPORT CARD

Overall Grade	B
General Content	B
Presentation	B
Pedagogy	B-
Teacher Usability	B
Water Resources	B+

COMMENTS

General Content
Blends history and geography to introduce students to the water situation in Southern California. "This should be treated as a supplemental piece to explain water distribution systems in California."

Presentation
"Good illustrations of the water cycle and groundwater." Reviewers were pleased that a female was chosen as the lead character; some concern, however, was voiced over the stereotyping. "Format is easy to follow."

Pedagogy
"Sixth graders would enjoy the video." "Materials are colorful and appealing."
"Needs more hands-on activities ... a lot of reading and writing."

Teacher Usability
"Video is available in Spanish."

Specific Content on Water Resources
Focuses on Southern California. "'Dilutes' the state water controversies and does not tell the entire story [political, ecological, and socio-economic factors]."

LESSON 9: Wise Water Use

Vocabulary:
- **xeriscape**—lanscaping that doesn't require a lot of water

Materials:
- Student booklets, page 15
- Home leaflets

Advance Preparation:
- (Optional) Prepare questions and baskets for water basketball in procedure C.

Procedures:

A. Have students read and discuss "Wise Water Use"

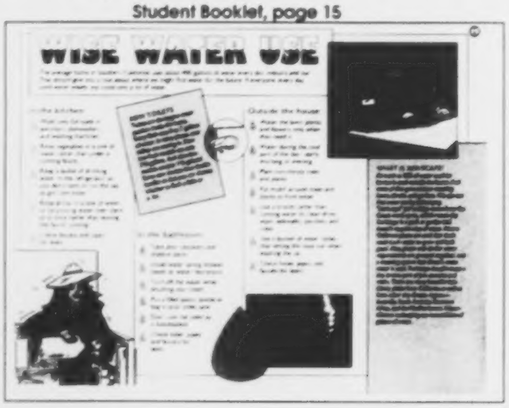
- Ask students to open their booklets to page 15. Have a student read the text under the title "Wise Water Use."
- Tell students that this page shows various ways that they can use water wisely. Have individual students read the various conservation practices listed and the sidebars about new toilets and xeriscape.
- Ask students if they can think of any other ways to use water wisely.

B. Have students complete and take home the home leaflets

Note: *On page 2 of the leaflet is an optional tear-off portion that can be signed by parents and sent back to school with the students. If you choose to have this form returned, check the water drop or be sure to have students check it.*

- Distribute a home leaflet to each student.
- Explain that this leaflet tells their parents a little about the *California Smith* program. Have students open the leaflets and look at the "Home Water Investigation" for them to do with their families. Tell them that this investigation will show where their families do and do not use water wisely.
- Encourage students to do the investigation with their parents. Tell them to be prepared to share with the class what they discovered about wise water use in their homes.
- Have students turn to the back page of the leaflet and fill in their names. Ask a student to read the text under the title "Water Use Investigation." Point out to students that for every activity listed, a wise use and an unwise use are shown.
- Ask students to get out their lists where they checked how often they did certain water use activities. Have students transfer their check marks to this "Water Use Investigation," checking the appropriate column for "unwise use" or "wise use" for each activity. Work through an example on the chalkboard.

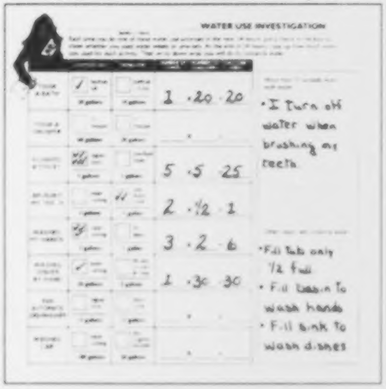
Student Booklet, page 15



WISE WATER USE

- Have students fill in the blank spaces showing the number of times they did each activity and the number of gallons that activity used *(e.g., either **20** gallons for a full bathtub or **10** gallons for a 1/2 full tub.)*
- Have students multiply the numbers to find out how many gallons of water they used for various activities in a day.
- Ask students if they are surprised about how much water they used for any activities. Ask how else they used water during those 24 hours.
- Ask students to look at the last column on the page. Have students first write what they already do to conserve water. Then have them write other ways that they could be wise with water.
- Ask various students to share what they have written.

Sample Student Water Use Investigation



WATER USE INVESTIGATION

1 · 20 · 20

5 · 5 · 25

2 · ½ · 1

3 · 2 · 6

1 · 30 · 30

• I turn off water when brushing my teeth.

• Fill tub only ½ full

• Fill basin to wash hands

• Fill sink to wash dishes

- Remind students to share the home leaflets with their parents.

C. Conduct a "water basketball" review

- Tell students that they are going to play "water basketball."
- Divide the class into two teams. Explain that each team will alternate getting a chance to make a basket by answering a question. If they make the basket (that is, answer the question right), their team gets 2 or 3 points, depending on the question. Then it is the other team's turn. If they miss the basket (that is, answer the question wrong), then the other team gets a chance at a 1 point "free throw" question in addition to their regular turn.
- Either alternate asking the 2 and 3 point questions to the teams, or prior to the game, prepare "baskets" for each team. Write each question on a separate slip of paper, indicating the number of points after the question. Give each team an equal number of 2 and 3 point questions. Put the 1 point "free throw" questions in a separate basket between the two teams. Instead of asking the questions, have a member of each team pull a question out of their basket when it's their turn to shoot.
- Either have individual team members answer the questions, or allow teams to work together on the questions.
- Keep score on the chalkboard.

D. Have students continue work on presentations

- Remind students that tomorrow they will be presenting their debates.
- Allow students to work with their debate teams on their presentations. Encourage them to have prepared lists so that they can argue for or against their topic. Provide guidance for any teams that are having difficulty.

E. Conduct additional activities

- **Search for water waste.** Have students look around the school for examples of water waste and for ways to save water.

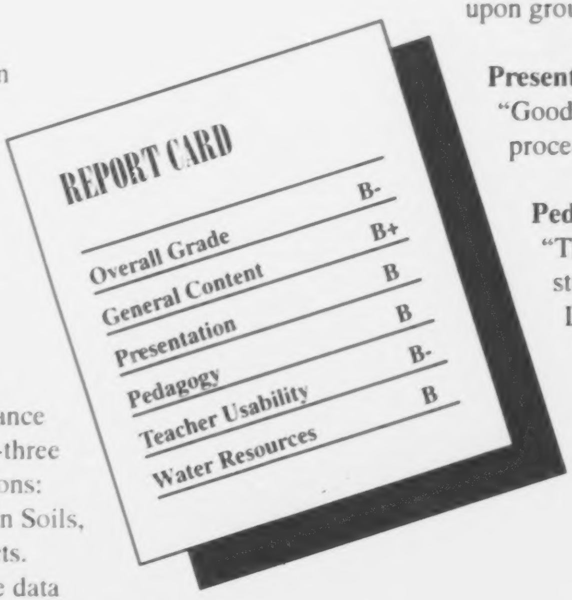
Groundwater: A Vital Resource

Tennessee Valley Authority
Water Quality Department Library
1101 Market Street, 2C Haney Building
Chattanooga, Tennessee 37327
(423) 751-7338

🌧 🌧 🌧

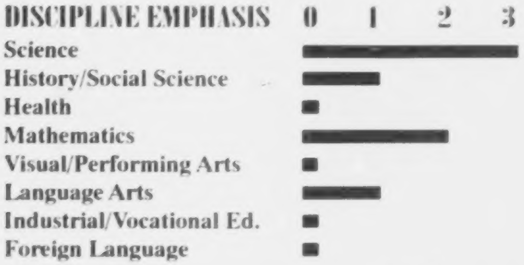
Publication is no longer available from the Tennessee Valley Authority. Limited copies are available from the Department of Water Resources [(916) 653-1097] which has been granted permission to reprint the material for educational purposes only.

"Groundwater, A Vital Resource" (61 pages) focuses on the role and importance of groundwater and aquifers. Twenty-three activities are organized into four sections: The Water Cycle, Water Distribution in Soils, Water Quality, and Community Impacts. Background information, reproducible data sheets, groundwater maps, and a glossary are provided.



REPORT CARD

Overall Grade	B-
General Content	B+
Presentation	B
Pedagogy	B
Teacher Usability	B-
Water Resources	B



COMMENTS

General Content
"This curriculum offers effective lessons on the community impact upon groundwater."

Presentation
"Good diagrams." "Objectives, materials, preparation and procedures are crisply presented."

Pedagogy
"The science and math skills may be difficult for many students to understand." "Too few diagrams to support LEP students and other visual learners." "The lesson on 'Groundwater Rights' is excellent."

Teacher Usability
"Needs more background information."

Specific Content on Water Resources
Focuses on the movement and potential contamination of groundwater. "Leaves out the magnitude of groundwater vulnerability." "Somewhat regional to Tennessee Valley."

201

200

ILLUSTRATING THE WATER TABLE

GRADES 4-8

OBJECTIVES

The participants will become familiar with the meaning of the term water table.

The participants will recognize that the water table is one of the contributing factors in the existence of streams, swamps, and lakes.

MATERIALS

- wide-mouth glass jar
- a glass
- chalkboard and chalk
- crayons
- a mixture of sand and gravel
- water
- paper and pencil

PREPARATION (BACKGROUND INFORMATION)

Groundwater is water that has sunk into the ground and is held under the surface. Rain seeps through the top layers easily. The earth near the surface is loaded with tiny air spaces. Even the rocks have cracks and pores through which water can find its way. But when it reaches clay or impervious rock, it will not sink any farther.

As more water sinks into the ground, it begins to collect above the bedrock or dense soil. When the ground has as much water as it can hold, it is said to be saturated. The ground becomes saturated from the rock or dense soil up, and the top level of this water rises towards the surface. This uppermost level is called the water table. The area of dry ground above the water table is called the zone or aeration. After heavy rains, the table is nearer the surface, and in dry weather it drops again.

PROCEDURE

1. Fill a wide-mouth glass jar three-fourths full of sand and gravel mix. Next, use a glass to pour water down the side of the jar until the water level rises about half way up the side of the jar. This water level should represent the level of the water table. Use a marking instrument of some kind to mark the present level. Show the students that if you add more water, the water table will rise. (See diagram page 23.)
2. On the chalkboard show that wherever the land surface dips below the water table, groundwater flows out to the surface. This forms springs, swamps, or lakes. Also tell the class that during dry weather periods the water table level goes down and some streams and swamps may dry up.
3. Aid discussion about the experiment by asking students to explain how different points in the experiment relate to the actual conditions in the environment.

HOW DIFFERENT SOILS AFFECT THE MOVEMENT OF WATER

8. Fill out the following chart with students on board.

DATA AND OBSERVATIONS

	TIME		
CUP	WATER IN	WATER OUT	OBSERVATIONS
A			
B			
C			

FOLLOW-THROUGH (QUESTIONS)

1. Which soil sample is the most permeable?
2. Which soil sample is least permeable?
3. How does the addition of gravel affect the permeability of clay?
4. How does soil type affect the movement of groundwater?
5. Can soil type protect groundwater? Which one? How?

REFERENCE

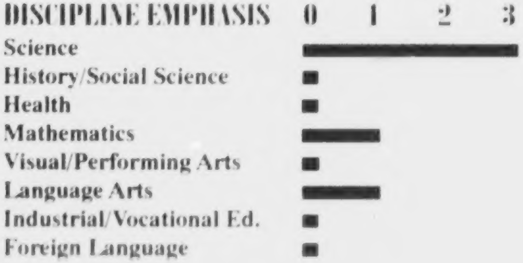
Focus on Earth Science, Teacher's Resource Manual, by Charles E. Merrill Publishing Company. Copyright 1984.

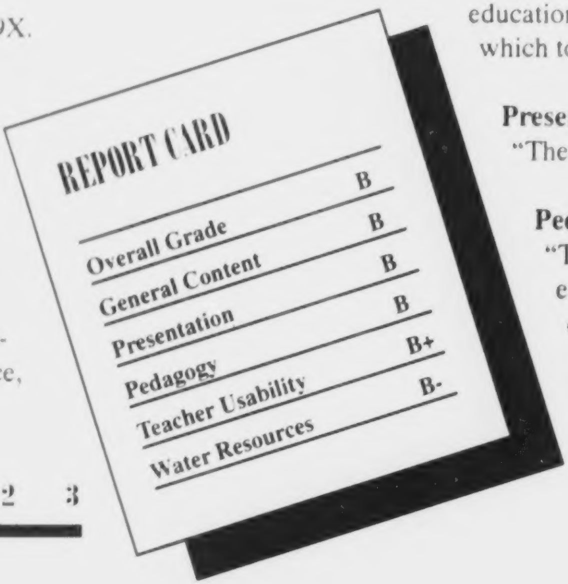
Water, Stones, and Fossil Bones

National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3000
(800) 722-6782

$18.50. 1991. 140 pages. Item PB089X.

"Water, Stones, and Fossil Bones" is designed to integrate earth science concepts into the teaching of elementary science. Activities begin with a focus on a particular concept and a challenge in the form of a question or problem. Hands-on procedures and further challenges enable students to explore space, land, water, air, and the earth's past.





REPORT CARD

Overall Grade	B
General Content	B
Presentation	B
Pedagogy	B
Teacher Usability	B+
Water Resources	B-

COMMENTS

General Content
"Treat this as a collection of lessons - not as an environmental education curriculum." "A good source of water lessons from which to choose."

Presentation
"The format is easy to follow."

Pedagogy
"This offers several engaging, easy-to-use activities that explore the relationship of water and earth sciences." "The questions asked are thought-provoking and the 'Further Challenges' help expand the lessons."

Teacher Usability
"Needs more teacher background and measureable objectives."

Specific Content on Water Resources
A collection of science activities that relate to water, but do not address ecological or political issues.

205

204

21 Soil Percolating

BY MICHAEL J. DEMCHIK

Materials and Equipment:

Each group of students will need

Soil samples

A garden trowel

A plastic container for each sample to be collected (margarine tubs)

3 paper cups per soil sample

A pencil

Cotton

A graduated cylinder (50 ml or larger)

A funnel

A watch or clock with a second hand

Paper

Focus:

Most of the rain that falls on land soaks into the ground; the rest runs off into streams and rivers. How well rain soaks in depends on a number of factors including the slope of the land, the amount of open space between soil particles (the porosity of the soil or rock), and the soil or rock's ability to allow water to pass through (its permeability).

Porosity is governed by the shape of the particles, how tightly the particles are packed, and how many different sizes of particles there are. These characteristics, and hence the amount and rate that water soaks in, can vary among different soil layers. This activity will demonstrate the variation in the rate that water moves through different soil layers. The rate that water moves through a soil is called the percolation rate.

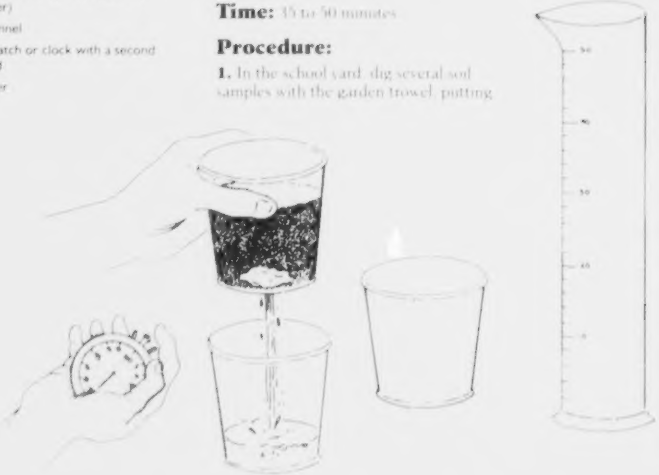
Challenge:

Can you predict the varying rates at which water will soak into different types of soil?

Time: 35 to 50 minutes

Procedure:

1. In the school yard, dig several soil samples with the garden trowel, putting each sample into a plastic container. All of the samples should be from the same hole, but at different depths.



2. Back in the classroom, punch a hole with a pencil through the bottom of one paper cup for each soil sample collected. Then place a wad of cotton or similar material in the opening, but do not pack it tightly.

3. Fill this paper cup two-thirds full with the soil sample. With watch in hand, add 50 ml of water to it. Hold the cup over the second cup to catch the water as it flows through. Start timing when water emerges from the bottom of the cup and collect the flow for 30 seconds, or some other arbitrary amount of time that flow would be uniform.

4. Using the funnel, pour the percolated water collected during the 30 seconds into the graduated cylinder, and record the volume.

5. To determine the rate of flow through the sample, show students how to divide the amount of percolated water in milliliters by the time period in seconds. As an example, 45 ml percolated through a sample, so 45 is divided by the amount of time required for the water to pass through the soil (30 seconds): 45 ml/30 sec = 1.5 ml per second. Thus 1.5 ml per second is the rate of flow.

Further Challenges:

Try this activity with different types of soils: sand, clay, loam or a combination. Or select various materials such as rotted wood, dried leaves, crushed rock, or other materials of your choice that might reduce the rate of flow. Grind up each sample and place equal quantities of each in the samples tested. Make some predictions before trying these activities.

The Author

Michael J. Demchik, Ph.D., teaches chemistry and physics at Jefferson High School in Shenandoah Junction, WV.

Learning To Be Water Wise and Energy Efficient

National Energy Foundation
5225 Wiley Post Way, Suite 170
Salt Lake City, Utah 84116
(801) 539-1406

Prices vary (approx. $20.00 - $30.00 per student/household). 1995. 177 pages. Only available as part of the Water Wise and Energy Efficient program. Corporate sponsorships are frequently available.

One teacher's guide, 24 student workbooks, a Home Retro Kit of energy- and water-saving devices including a high efficiency shower head, sink aerator, compact fluorescent lamp, and lawn watering rain gauge, and an 18-minute video on installation techniques combine to create the "Learning To Be Water Wise and Energy Efficient" package. Twenty-one instructional activities and accompanying posters are provided in the Teacher's Guide, focusing on water and energy efficiency through classroom instruction and the use of the devices installed in each students's home.

REPORT CARD

Overall Grade	B
General Content	B
Presentation	B
Pedagogy	B
Teacher Usability	B+
Water Resources	B-

COMMENTS

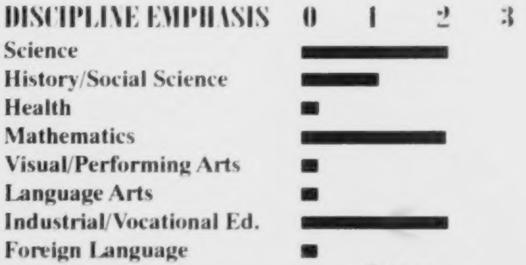
General Content
"While limited in scope, this offers good water conservation surveys and hands-on activities... surveying, measuring, and applying conservation techniques."

Presentation
"The packaging is excessive."

Pedagogy
"Very concrete water conservation lessons."

Teacher Usability
"Good water conservation surveys." "Activities are easy to go through in the binder."
"Program requires a sponsor and cooperative parents."

Specific Content on Water Resources
Approximately one-third of the material focuses on water resources. The rest deals with energy conservation.



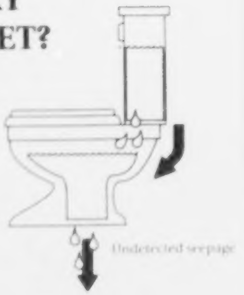
WATER SAVING AND LEAK TESTING

Activity Nine

Does your toilet tank leak? Who knows? Toilet tanks usually don't leak water onto the floor. You can't see the leaks that exist within the toilet. So how can you tell if you have one? And why should you care?

A leaky toilet can waste up to 10,000 gallons of water a year! That's enough water to take a bath a day, every day, 365 days a year! Believe it or not, one of every five toilets leaks. Therefore, there's a good chance yours does.

LEAKY TOILET?



Leaky toilets can waste 10,000 gallons of water per year.

When toilets leak, clean water in the tank slowly seeps into the toilet bowl. Because the water level in the toilet bowl must always stay at the same level, this clean water then drains into your sewer pipes. This water disappears from your home without ever being used. To find out if your toilet tank has a leak, try this simple test.

The Leak Test

1. **With your parents' supervision**, remove the toilet tank leak detector tablets from your box of water and energy conservation materials. Unwrap the tablets. They are harmless, but keep them away from little brothers and sisters anyway.
2. With the help of an adult, take the lid off of your toilet tank.
3. Flush the toilet.
4. As the tank starts to fill with water, drop in the tablets. Be sure to drop the tablets into the tank, not the toilet bowl.
5. Wait ten minutes.
6. Check your toilet bowl. The water in the bowl will change colors if you have a leak.

Discuss the results of your test with your parents. Many leaks can be repaired without the help of a plumber. Your local home improvement center should be able to help you.

Overfilling?

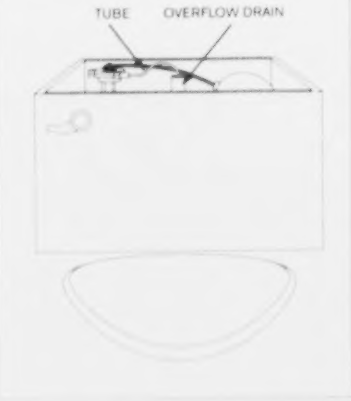
Well, now that you have learned just about everything there is to know about a toilet, and water conservation, there is still something else! Your toilet probably is overfilling. What happens is that more water goes into the bowl than it needs during the filling of the storage tank. This can be one half to one whole gallon of water more than you need to use. To correct this problem, a little part called a fill-cycle regulator can help. The regulator stops about half of the water that enters through the overflow tube. This is another example of how something very small can make a very big conservation difference. And, using the fill-cycle regulator doesn't affect how your toilet flushes. Also, you will never have to replace the regulator, because it will last the lifetime of your toilet.

To make your toilet more water and energy efficient, you can put one of these fill-cycle regulators in right now. It doesn't take any special tools to install, and only takes a few minutes from start to finish.

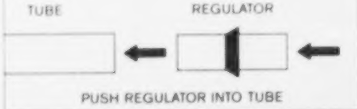
Look in your kit and find the small packet with two little blue regulators in a plastic pouch and complete the following instructions:

Here's How to Install Your Fill-Cycle Regulator at Home

1. Remove lid from toilet tank. Inside, you will see a flexible plastic or rubber tube. Remove the free end of this tube from inside the overflow drain (see illustration below).



2. Insert the fill-cycle regulator into the end of the tube (see the illustration below). If there is an adaptor on the tube, remove it, and insert the regulator far enough into the tube so the adaptor can be replaced.
3. Return the tube to its original position in the overflow drain. Your regulator is now going to save water and energy every time you flush!



BONUS ACTIVITY

In the puzzle below, find the words which have to do with water. Words go up, down, across, diagonally and backwards.

A B E U J I C E D W O G Y W K X M O
V A P O R Q R C T U V W O S I N K K
J D Q I C L E O S M A D X B K F O P
E R R E T A W I E C X O D F Q I C J
E S T Y U F W E C V B H J U D R G E
J K T E S H O W E R E Q A Z X E G H
B A R P L I J Y G T A R V B N W U E
J E E I M V M T Y U C I K H G O D K
F L N B G I F D C T L O N J I N L L
J K L I H O S B V F O D E R F S H H
J K Y H N J I T P L U K H N J B G V
B A T H T U B K M U D H N R J U Y H
L K J H Y H N U J M S K D R I N K D
J M R G B Y T R F D S J H G F L K J

WORDS:

Across: ice, vapor, sink, shower, bathtub, drink, mud
Up: leaks, snow
Down: clouds
Diagonally: mist, rain
Backwards: dams, water

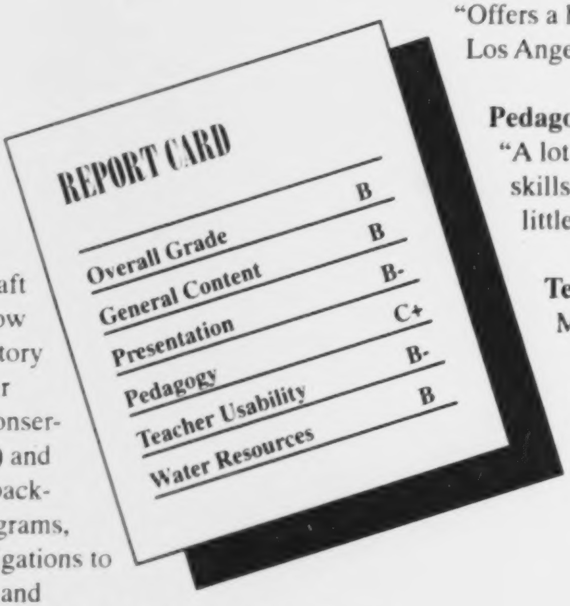
© [illegible] National Energy Foundation. All rights reserved.

Water from Nature to You

Los Angeles Department of Water and Power
Educational Services, Communications Services,
Room 1510
P.O. Box 111
Los Angeles, California 90051
(213) 367-1343

No charge to public or private schools within the City of Los Angeles. Approximately $75.00 per classroom set for schools outside of the City of Los Angeles. 1996. Bilingual.

Recently published (and reviewed in draft form), "Water from Nature to You ... How Does It Happen?" focuses upon the history of Los Angeles water supplies, the water cycle, water quality issues, and water conservation. The Teacher's Guide (67 pages) and Student Workbook (50 pages) provide background information, regional maps, diagrams, activities ranging from scientific investigations to puzzles, a glossary, extended activities, and evaluation tools. A Water Conservation Checklist and School Water Survey are also provided.



REPORT CARD

Overall Grade	B
General Content	B
Presentation	B-
Pedagogy	C+
Teacher Usability	B-
Water Resources	B

COMMENTS

General Content

Provides a good understanding of the source of Los Angeles water. "Offers a history of water resources and use specific to Los Angeles."

Pedagogy

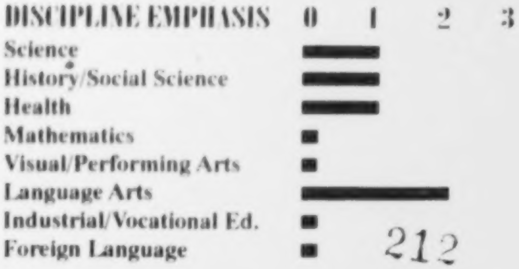
"A lot of paper and pencil fill-in." "Few higher order thinking skills and process skills are utilized." "No action projects ... little stewardship."

Teacher Usability

Materials are available in Spanish.

Specific Content on Water Resources

Information is specific to the Los Angeles region and does not address conflicts or ecological impacts of water use.



SCHOOL WATER SURVEY ACTIVITY

EXTEND

Problem: HOW MUCH WATER, ON THE AVERAGE, DO YOU USE IN YOUR SCHOOL?

Purpose: The purpose of this activity is to help you calculate how much water you personally use during the day at school and compare it to the average per person use in the school.

Time: Collect data for one week.

Materials: School water bill for previous month and graph paper.

Procedure: You will determine how much water you use at school by developing a water use chart and then graphing the results. You will then compare your individual use with the average per person school use obtained from the school water bill. You and your class, with approval from your teacher, may devise your own procedure for constructing this or additional surveys.

Directions: Students estimate and record their water usage each day for one school week. At the end of the week the student's daily totals are made into individual line graphs.

A. INDIVIDUAL STUDENT WATER USE RECORD.

1. Record on a water chart each time one of these activities is conducted. Use the formulas to determine total volume used.

Water Activity		**Number of Times/Day**	**Total**
Taking a school shower	____	times	____
	____	minutes per shower times 6 gallons/minute	
Flushing a school toilet	____	times 5 gallons	____
Washing hands	____	times 2 gallons	____
Drinking water from a school fountain	____	times 1/4 gallons	____
		Total gallons used in 1 day	____

2. Repeat for a full school week.

	M	**T**	**W**	**Th**	**F**
Totals	____	____	____	____	____

SCHOOL WATER SURVEY ACTIVITY

EXTEND

3. Make a line graph of the data from the estimated water use chart. Plot number of gallons of water used against each day.

4. How much does your water use change from day to day?

____

B. AVERAGE PER PERSON ACTUAL SCHOOL WATER USE.

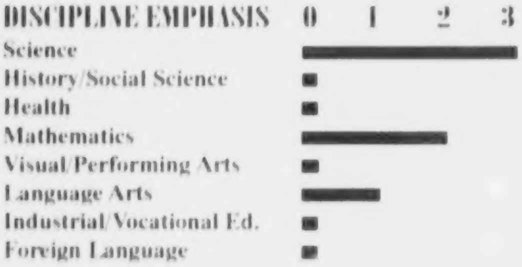
1. Determine how many gallons of water were used by the school during the last monthly water billing period.
2. Divide the total number of gallons used in that billing period by 20 days.
3. Take the above number and divide it by the number of people in the school. This is the number of gallons used by each person in the school in one day.
4. Compare this school wide average number with individual student estimated averages obtained in part A. Place data on a bar graph.

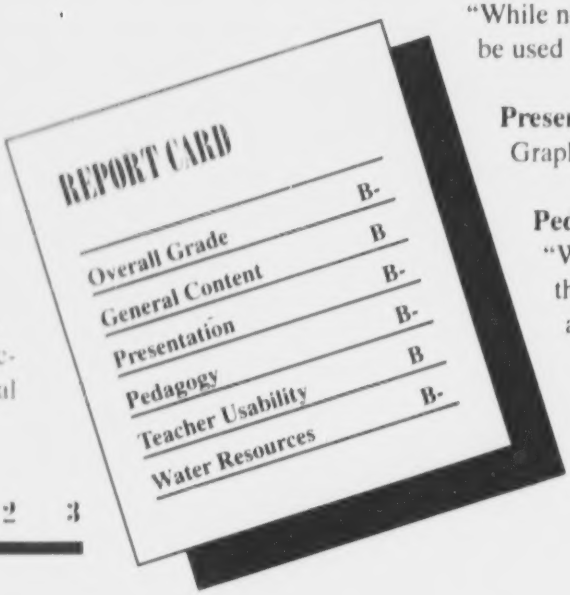
Water Cycle, the Earth's Gift

Math/Science Nucleus
4009 Pestana Place
Fremont, California 94538
(510) 490-6284

$19.95. 1992. 272 pages.

"Water Cycle, the Earth's Gift" offers lesson plans and activities related to water, oceans, atmosphere, and weather. The "cookbook" format outlines twelve activities centered around four labs for a four-week unit per grade level, K - 6. Background information and reproducible worksheets are provided in a spiral bound format.





REPORT CARD

Overall Grade	B-
General Content	B
Presentation	B-
Pedagogy	B-
Teacher Usability	B
Water Resources	B-

COMMENTS

General Content
"An effective set of science activities to use for the study of water." "While not environmental education material, 'Water Cycle' could be used to augment a study of water."

Presentation
Graphics need improvement.

Pedagogy
"Water Cycle" offers hands-on labs, stimulating students to think. "Excellent treatment of the water cycle." Content and activities are spiraled through the grade levels.

Teacher Usability
Extensive background is provided.

Specific Content on Water Resources
Background information such as maps and weather satellite photographs are regionally specific to the San Francisco Bay area. The information and activities on the water cycle are thorough.

WATER CYCLE - WATER (5)

PRE LAB

OBJECTIVES:

1. Introducing the water cycle.
2. Analyzing why water is important.

VOCABULARY:

condensation
evaporation
precipitation
water cycle

PROCEDURE:

MATERIALS: overhead on water cycle (optional)

For the next four weeks, students will look at the properties of water, oceans, the atmosphere, and the weather. Remember that all of these subjects are related and your lectures should reflect this. Look at the beginning of this manual for more background information on an introductory lesson.

Discuss with students the following major points about water or the hydrologic cycle. Draw the diagram of the water cycle.

Water is our most common natural resource. It is essential to the biology and chemistry of all living things, it plays a major role in shaping the earth and is an active agent in many physical reactions.

There is plenty of water on Earth, but 97% of this water is saline (contains dissolved salts). Only 3% is fresh and about two thirds of that amount is locked up in polar ice caps and glaciers; about one third can be found as ground water, lakes, and in the atmosphere.

Water exists in three states of matter: solid (ice), liquid (water), and gas (vapor) at normal conditions. Water is a colorless, odorless, tasteless liquid with a melting point of 0° centigrade and a boiling point of 100° centigrade.

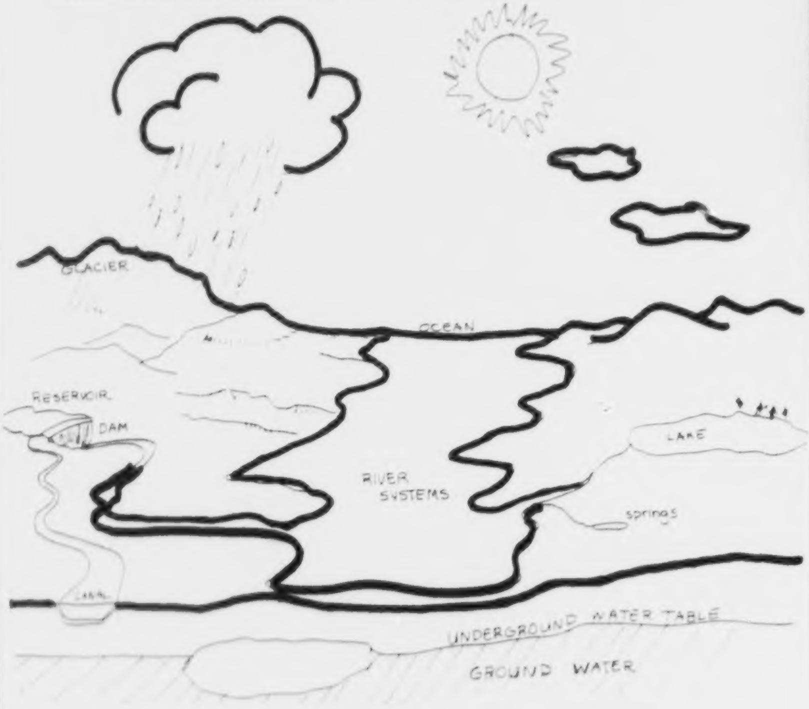
Hopefully this diagram should be familiar to students and they should be able to tell you about each of the components. Ask them which are human-made portions of the water cycle? (Reservoir, dams and canals.) Where does a spring get its water supply? (Usually from the ground water percolating up.) Where does water from the mountains wind up? (The oceans.) Which is the newest water? (Rain.) Oldest? (Oceans.)

WATER CYCLE - WATER (5)

PRE

NAME ____________________________________

ILLUSTRATE THE WATER CYCLE BY USING AN ARROW TO SHOW THE DIRECTION OF THE MOVEMENT OF THE WATER. BE SURE TO LABEL BOTH EVAPORATION AND CONDENSATION.

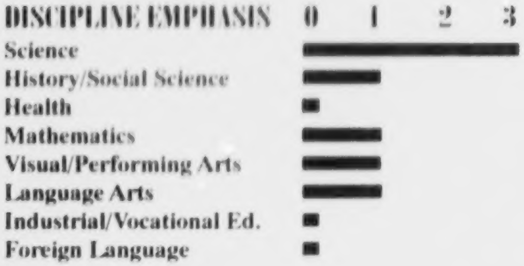


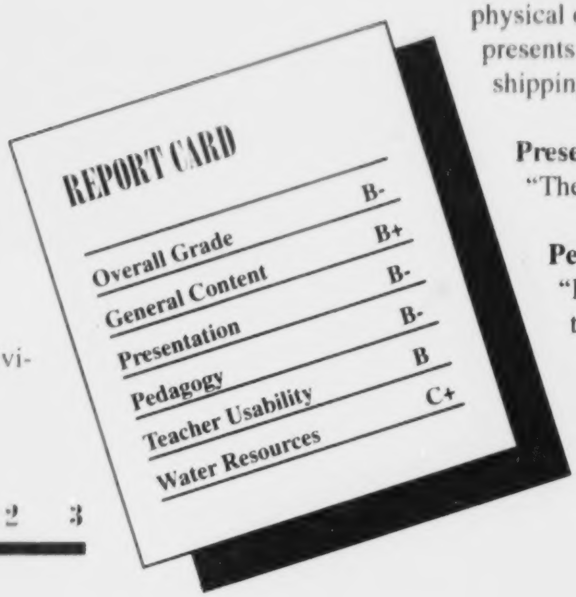
Wet and Wild: The Physical Ocean

USC Sea Grant
Hancock Institute for Marine Studies
University of Southern California
Los Angeles, California 90089-0373
(213) 740-1961

$10.00. 1983. 81 pages. Bilingual

One of six units, "The Physical Ocean" (Unit 1) explores the physical properties of water within the context of oceanography. The hydrologic cycle, currents, waves, ocean temperature, and climate are investigated through 26 hands-on activities. A supplemental activities and resources section is also included.





REPORT CARD

Overall Grade	B-
General Content	B+
Presentation	B-
Pedagogy	B-
Teacher Usability	B
Water Resources	C+

COMMENTS

General Content
"Wet and Wild" offers a series of activities for an in-depth study of physical oceanography. As a physical science curriculum, "it presents interesting information, such as ocean currents and shipping lanes."

Presentation
"The page formatting [layout] is hard to adjust to."

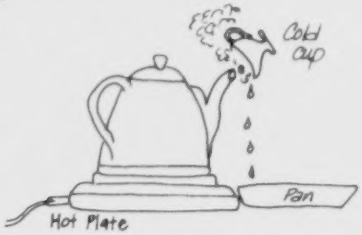
Pedagogy
"Fairly clear, measureable objectives are stated." "Activities tend to be interactive, but fairly simplistic."

Teacher Usability
Materials are available in Spanish.

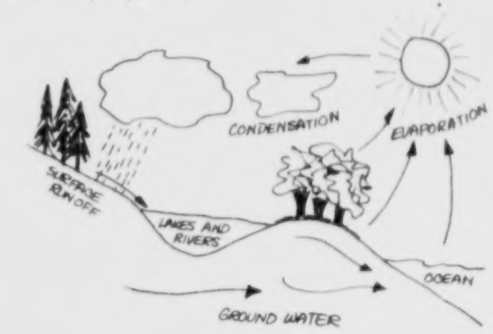
Specific Content on Water Resources
Physical oceanography and "marine water resources" are the focus. "Offers good basic water chemistry and physical properties."

The hydrologic cycle

	Grades K-3	Grades 4-6
Objective	Given the appropriate information, the student will be able to illustrate and discuss the fundamentals of the hydrologic cycle.	Given the proper information, the student will be able to illustrate and discuss the hydrologic cycle.
Materials	Teapot with spout, coffee cup, hot plate, water, and flat drip pan.	Glass and cold water.
Activity	Place a teapot half full of water on a hot plate. When it starts to boil, place a cup at a 45° angle above the steaming spout. Place the pan under the place where the water condensation will be falling. Observe the water dripping.	On a warm day put a glass of cold water on a table. Drops will form around the outside of the glass.
Questions	*What has happened to the water?* (It changed to steam.) *What happened to the gas?* (It changed back to water and fell into the dish.) *How does this happen in nature?*	*Why do the droplets form? Where else in nature does this occur?*



	Grades 4-6
Materials	Paints and paper for mural.
Activity	Make a land and seascape scene to depict the land, saltwater, freshwater, plants, animals, and clouds. Begin with clouds, and show by arrows the travel of water to and from all features mentioned above. List some terms which may relate to the water cycle. Place a list on the board. For example: Evaporation/Vapor/Clouds Surface Run-off/Transpiration Condensation/Precipitation Ground Water/Percolation Use these terms as labels in the mural.
Questions	*How many states does water go through in the hydrologic cycle? On what kind of day would there be the most evaporation? The most condensation (precipitation)?*

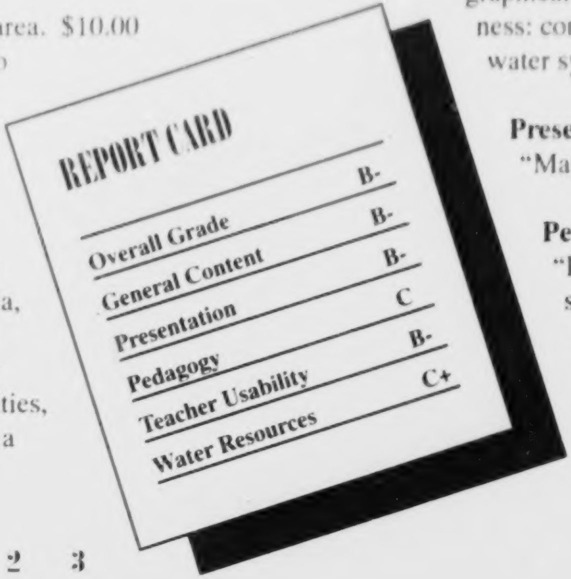


Where in the World Is the Water?

San Diego County Water Authority
3211 Fifth Avenue
San Diego, California 92103
(619) 682-4100

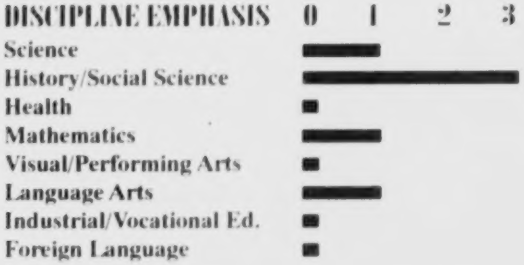
No charge within San Diego service area. $10.00 (includes shipping) outside San Diego service area. 1994. 65 pages.

Using reference maps, fact sheets, and student worksheets, "Where in the World Is the Water?" compares the geography and water resources in California with those of Brazil, Burma, Egypt, Mexico, the Netherlands, and Norway. Appendices include a water conservation game, enrichment activities, a glossary, field trip suggestions, and a bibliography.



REPORT CARD

Overall Grade	B-
General Content	B-
Presentation	B-
Pedagogy	C
Teacher Usability	B-
Water Resources	C+



COMMENTS

General Content

"Lessons about California geography are followed by world geographical comparisons." "This is great for water resource awareness: comparing six countries to California in terms of major water systems, topography, and population."

Presentation

"Maps are of high quality."

Pedagogy

"Independent student work is emphasized - almost exclusively paper and pencil work unless extension activities are used." "Objectives are clearly written."

Teacher Usability

"Useful for map study."

Specific Content on Water Resources

"Where in the World" is a global geography unit comparing physical features of countries. "Water is not presented as a resource related to human needs and that ramifications exist regarding water use."

LESSON II

CALIFORNIA GEOGRAPHY AND WATER RESOURCES

Objectives

Students will be able to read a map and locate various natural and man-made features and label their own maps.

Materials Needed

California and teacher background information, comparison chart, student maps of California.

Time

One class period.

Lesson Format

Before beginning the lesson, read the California background information sheet. Present that information to the students. Hand out the student maps of California and have the students look at the comparison chart for their country. Explain that they will complete their maps as they review California geography.

Discuss the geographic features and weather and rainfall patterns of California. Locate the following on the California Map:

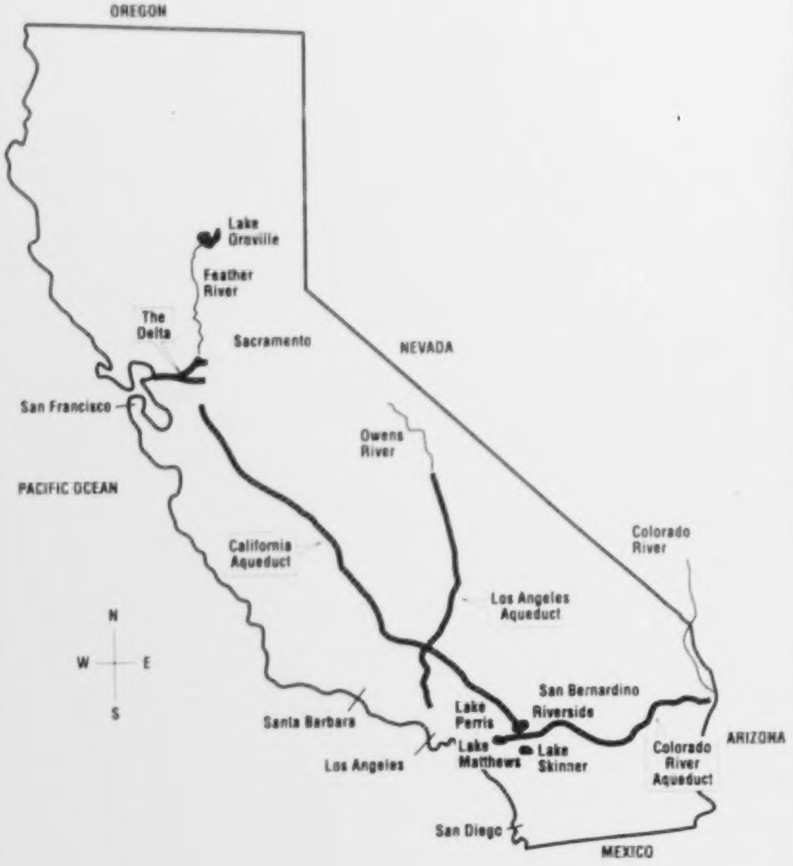
- Los Angeles Aqueduct
- Colorado River Aqueduct
- Salton Sea
- California Aqueduct
- Lake Oroville

Have the students look at their comparison charts of California. Briefly look at and review the first six sections of the comparison charts. Explain that the last two sections are different on their chart depending upon the country they are studying. Have students representing each of the six countries, share what is on the last two sections of their charts. Explain to the students that they will complete their country's portion of this chart when they do their research.

Locate the following places on the map of California. Have the students locate, draw and label these points on their own map of California.

- Lake Tahoe
- Mt. Whitney
- Death Valley
- Sierra Nevada Mountains
- Sacramento River

California

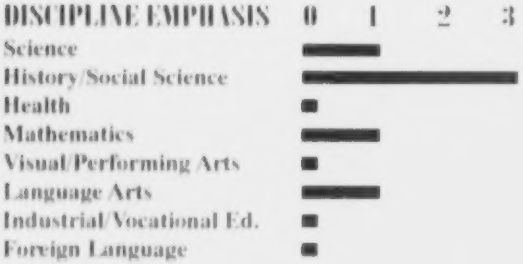

OREGON
Lake Oroville
Feather River
The Delta
Sacramento
NEVADA
San Francisco
Owens River
PACIFIC OCEAN
California Aqueduct
Colorado River
Los Angeles Aqueduct
N
W
E
S
San Bernardino
Riverside
Lake Perris
Santa Barbara
Lake Matthews
Lake Skinner
Los Angeles
Colorado River Aqueduct
ARIZONA
San Diego
MEXICO

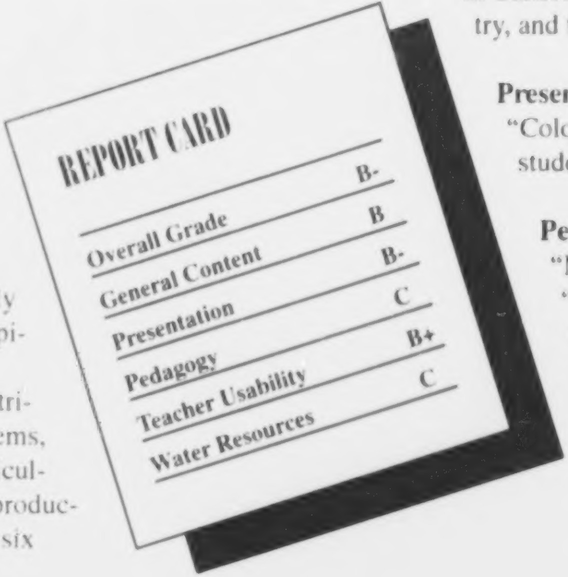
The Geography of Water

Metropolitan Water District of Southern California
Education Programs
P.O. Box 54153
Los Angeles, California 90054-0153
(213) 217-6398

$5.00. Materials are free in MWD Southern California service area. 1989. Folder format.

"The Geography of Water" offers a collection of lesson plans that focus primarily on the physical aspects of water distribution in California, namely physical features, elevation, and precipitation. Water is examined within the context of California's population, distribution of rivers and water supply systems, and the residential, industrial, and agricultural needs of the state. Forty-four reproducible worksheets and maps accompany six teacher booklets.





REPORT CARD

Overall Grade	B-
General Content	B
Presentation	B-
Pedagogy	C
Teacher Usability	B+
Water Resources	C

COMMENTS

General Content
"A good map unit for fourth grade." "Good straight forward lessons in California physical geography, population, precipitation, industry, and the interrelationships among them."

Presentation
"Colorful, easy to use maps." "High-quality, reproducible student worksheets."

Pedagogy
"Map study is the exclusive methodology." "Concrete, hands on activities are lacking." "Good, thoughtful suggestions are used as extensions of lessons."

Teacher Usability
Useful for California geography and social studies for fourth grade. "While not a curriculum, this could be used in conjunction with curricula to study California's water situation." "Teacher background information is needed."

Specific Content on Water Resources
Focuses on California water issues. "Misses the opportunity to talk about watersheds, lifestyles, and patterns of water use."

ELEVATIONS

QUESTIONS

?

Map #1 will help you learn many things about your state. The map shows some cities in California. It also shows elevations (where the mountains and valleys are located) and the directions: north, south, east and west. Use the map to do the activities and answer the questions below.

I. With your teacher's help, use a more detailed map of California or an atlas to locate the city where you live. On your own copy of the map of California, draw a star (*) in the exact location of your city and write the name of the city next to the star.

II. Look carefully at the arrows on your map which show the cardinal directions: north, south, east and west. Answer the following questions: (Circle the number of the answer your choose.)

A. I live in:
   1. Northern California
   2. Southern California

B. To the west of California is:
   1. Nevada
   2. Arizona
   3. The Pacific Ocean
   4. Oregon

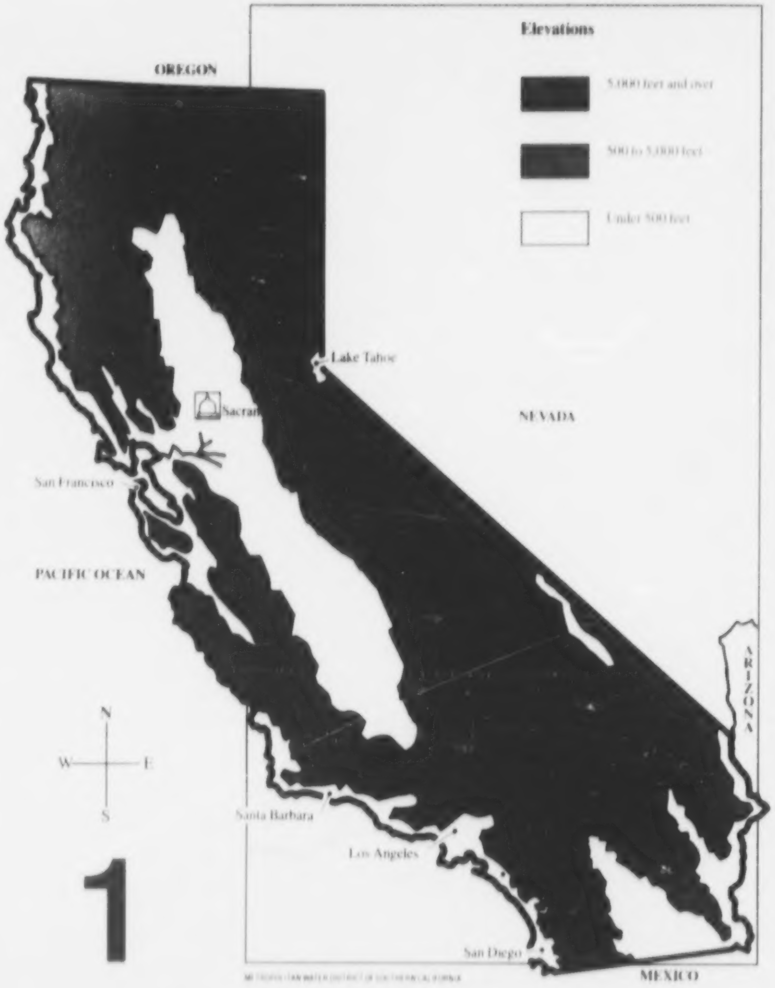
C. Lake Tahoe is mostly:
   1. north of Los Angeles
   2. south of Los Angeles
   3. east of Los Angeles

D. Fill in the blanks with "north," "south," "east" or "west":
   1. If I want to go to the mountains, I have to go ______.
   2. If I want to go to the beach, I have to go ______ or ______.
   3. If I want to go to Mexico, I have to go ______.
   4. If I want to go to Arizona, I have to go ______.

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

1

ELEVATIONS


Elevations
5,000 feet and over
500 to 5,000 feet
Under 500 feet
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
Lake Tahoe
Sacramento
San Francisco
Santa Barbara
Los Angeles
San Diego
N
S
E
W

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

GRADES 4-6

1

BEST COPY AVAILABLE

230

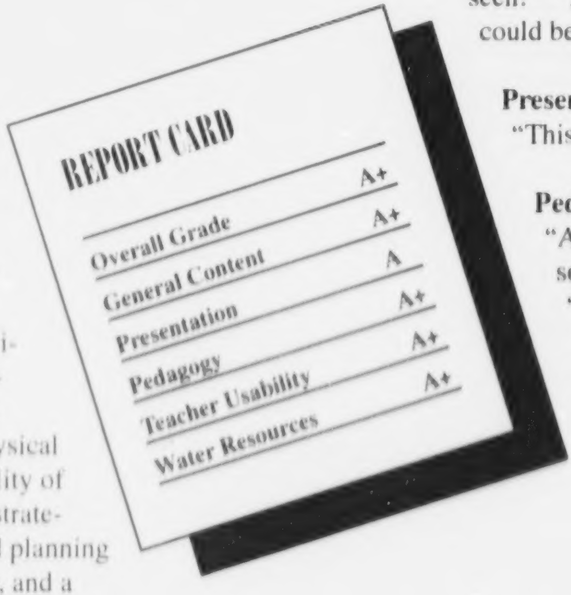
231

Project WET Curriculum and Activity Guide

The Watercourse and Council for
Environmental Education
c/o Montana State University
201 Culbertson Hall
Bozeman, Montana 59717-0570
(406) 994-5392

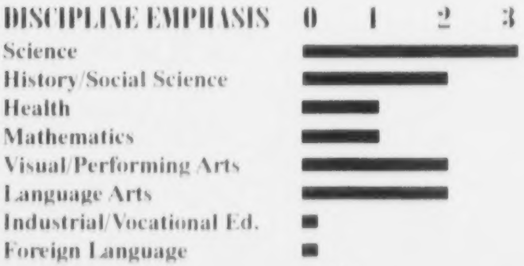
Only available through training workshop. 1995. 516 pages.

Project WET is a national water education program designed to promote awareness, appreciation, knowledge, and stewardship of water resources. This guide reflects these goals in a collection of 91 interdisciplinary activities for K - 12. Content focuses on the human relationship with water, as well as the chemical and physical properties of water, quantity and quality of water, ecosystems, and management strategies. Extensive cross-referencing and planning charts, a supplemental resource guide, and a glossary are provided.



REPORT CARD

Overall Grade	A+
General Content	A+
Presentation	A
Pedagogy	A+
Teacher Usability	A+
Water Resources	A+



COMMENTS

General Content

"This is one of the best teacher resource books that I have ever seen!" "'Awesome' - perhaps *the* prototype from which others could be modelled."

Presentation

"This is designed for ease of use."

Pedagogy

"Assessment strategies are outstanding." "Activities represent very creative ideas."

"Interdisciplinary with great depth and breadth."

Teacher Usability

"Activities are explained in detail." "The planning charts and indices are very helpful."

Applying activities across the grade levels is somewhat difficult without breakdown guidelines.

Specific Content on Water Resources

"An exciting and innovative array of environmental education water activities."

Hangin' Together

Grade Level:
Middle School

Subject Areas:
Physical Science

Duration:
Preparation time:
Part I: 20 minutes
Part II: 30 minutes
Part III: 30 minutes
Activity time:
Part I: 10 minutes
Part II: 50 minutes
Part III: 30 minutes

Setting: Classroom

Skills:
Gathering information (observing); Interpreting (inferring, translating); Presenting

Charting the Course
"Molecules in Motion" and activities on the structure of the water molecule can precede this activity. Follow with activities focusing on the physical characteristics and behavior of water (e.g., "H_2Olympics," "What's the Solution?"), evaporation/condensation ("Water Models"), ice ("Cold Cash in the Icebox"), and density ("Adventures in Density").

Vocabulary
heat sink, hydrogen bond, electromagnetic forces, polar, surface tension, solution

What has a tough skin, can make a mountain of sugar disappear, can keep elephants cool, and can crack giant boulders?

Objectives

Students will:

- illustrate the structure and intermolecular forces of the water molecule in relation to hydrogen bonding.
- explain the role of hydrogen bonding and its relationship with some of the unique characteristics of water.
- deduce how these unique molecular properties of water are critical to life on Earth.

Materials

- *Dark colored bottle*
- *Wool material* (optional)
- *Balloon* (optional)
- *Comb*
- *Running water* (if a water source is not available, have a student pour a slow, steady stream of water from a gallon jug)
- *3-foot-long (1 m) pieces of string or strips of cloth, one per student*
- *Copies of* ***Student Activity Cards***
- *Magnets*
- *Paper clips*
- *Forks*
- *Cups*
- *Sugar*
- *Oil*
- *Paintbrushes*
- *Copies of* ***Hydrocharade Cards***
- *Broom or meter stick*
- *Water*
- *Scrap paper*
- *Several pieces of string 13 inches (about 0.33 m long), 2 per student*
- *Tape*
- *Marking pens*
- *Chalk*

Making Connections

Children are familiar with rain, salt water, perspiration, and ice, but do they realize that the same unique feature of water makes all these forms of water possible? The water molecule's ability to bond with other water molecules allows it to bead up, to dissolve substances, to evaporate, to condense, and to be less dense as a solid. If water did not possess these qualities, life on Earth could not exist.

Background

Understanding the intermolecular forces of water requires a basic understanding of atomic and electromagnetic theories. These theories explain why the water molecule's shape causes it to be attracted to other water molecules.

The water molecule consists of two elements, hydrogen and oxygen, in the ratio of two hydrogen for every one oxygen. The formula for water is H_2O. Water molecules are said to be polar; that means they are like magnets. One end has a negative charge and the other has a positive charge.

The positive end of one molecule is attracted to the negative end of another molecule. When the molecules stay in contact with each other, a bond—called a hydrogen bond—forms between the two molecules. The structure and nature of the water molecule give it various interesting properties that are critical to life on Earth.

Student Activity Cards

Activity: *CALL ME BOND, HYDROGEN BOND*

Information: The surface of water acts like a skin that keeps some things out. The skin is actually a layer of water molecules held tightly together by hydrogen bonds. This is why water forms drops, and why some insects can skate on water's surface.

Challenge: Can you make water demonstrate the properties described in the paragraph above? Describe or draw a picture of how you did it. If you need help, send one group member to ask the teacher for suggestions.

Materials you will need: cup of water, paper clip, fork

Activity: *HOW CAN YOU TELL A POLAR MOLECULE FROM A POLAR BEAR?*

Information: More things dissolve in water than in any other substance. Some materials are magnetically charged (polar) and dissolve easily in water. Water molecules dissolve these materials by forming hydrogen bonds with each molecule in the material. Other substances are nonpolar. These do not dissolve or mix in water because hydrogen bonds are not formed.

Challenge: Which of these two materials is polar, oil or sugar? How can you tell? Send one group member to check with the teacher to see if your response is correct.

Materials you will need: cup of water, oil, sugar

Activity: *IT'S NO SWEAT . . . OR IS IT?*

Information: It is a very hot day. You and some friends decide to race around the block to the playing field. Suddenly, one of your friends stops and complains about feeling overheated. You happen to be carrying a bottle of suntanning oil and a bottle of water. One friend says oil will help cool down the overheated friend; the other claims water will work better.

Challenge: Which of your friends is right? Try spreading a thin layer of each liquid on your hand. Which one feels cooler? Suggest reasons for the outcome. Send one group member to check with the teacher to see if your response is correct.

Materials you will need: oil, water, paintbrush for each person

Activity: *FREEZING WATER IS A SWELL IDEA*

Information: You plan to go on a hike tomorrow. You want to bring along some water. You have water in both glass and plastic bottles. A friend suggests freezing the filled bottles overnight, so the water will still be cool when you need a drink.

Challenge: Which container of water should you put in the freezer? Draw a picture of and provide an explanation for what you think each might look like when you check the freezer in the morning. (Don't try this one at home!) Send one group member to check with the teacher to see if your response is correct.

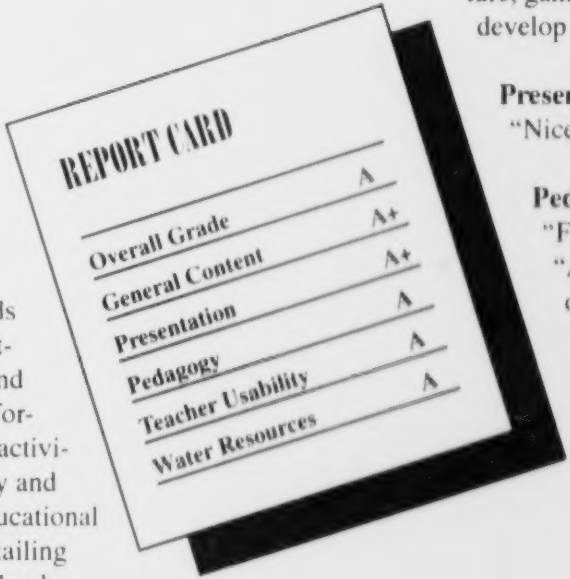
No materials needed; this is a mental lab!

WOW! The Wonders of Wetlands

Environmental Concern, Inc., and
The Watercourse
c/o Montana State University
201 Culbertson Hall
Bozeman, Montana 59717-0570
(406) 994-5392

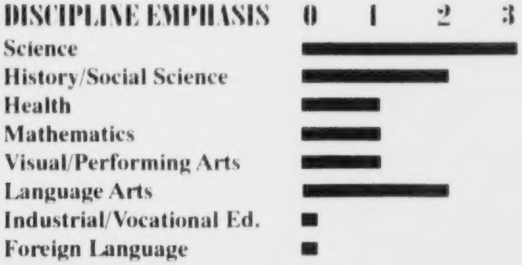
$15.95. 1995. 330 pages

"Wow! The Wonders of Wetlands" is divided into two core parts: an extensive teacher background section followed by 44 activities organized within five chapters: An Introduction to Wetlands, The Wetlands Community, The Role of Water in Wetlands, The Role of Soil in Wetlands, and Wetlands and People. Background information is cross-referenced to specific activities, designed to be taught thematically and cross-disciplinarily. A glossary, an educational resources section, and an appendix detailing plans for developing a schoolyard wetland habitat are also included.



REPORT CARD

Overall Grade	A
General Content	A+
Presentation	A+
Pedagogy	A
Teacher Usability	A
Water Resources	A



COMMENTS

General Content

"An outstanding K - 12 resource!" "A fine blend of science, literature, games, and discussions." "This is all an educator needs to develop an engaging water/wetland curriculum - a must!"

Presentation

"Nice artwork and visually-oriented materials."

Pedagogy

"Fully integrated materials and extensive resource lists." "Activities expose students to controversial issues that are openly presented." "Activities are broad in scope and progress from familiarization to hands-on study to social action."

Teacher Usability

"Extensive background information for teachers is included." "Suggestions for using the book to create units of three and five day duration are provided." "A water area is needed to implement the curriculum."

Specific Content on Water Resources

Thoroughly covers wetlands and related water issues.

Bog-Making Activity Sheet

1. To create the permeable lower layer of an artificial bog, first spread the perlite to an even depth on the bottom. Add 1-2 inches (2-5 cm) of gravel above that, followed by an even layer of the activated charcoal. These materials facilitate the processes of drainage and evaporation that occur in a natural bog.

2. Before adding the next layer, place several artifacts against the glass on top of the charcoal. A piece of wood, a nail, several pieces of fruit, and one cube of meat should be adequate.

3. Place 1-3 inches (2-7 cm) of peat moss above the charcoal. Compress this layer of peat with a block of wood or pack with your hands.

4. Arrange more artifacts on top of the compressed peat, so they can be seen through the tank glass.

5. Loosely pack sphagnum moss and the remaining peat moss, creating some topography, with a gentle slope toward a marked depression. Place a final layer of artifacts on the surface of the loose peat moss.

6. In the depressed section of your "landscape" bury the small water container, so that it is slightly below the surface of the bog. This simulates a small bog pond and helps add humidity to the tank.

7. Plant the carnivorous plants in the peat at the low end of the tank (with the dirt intact) and the water-tolerant varieties towards the high end (gently remove dirt and separate the roots). Pack soil around the plant bases. Aquarium may be covered with plastic wrap or sheet of glass.

8. Water the bog evenly with distilled or dechlorinated water (chlorine may harm the plants). Water the bog often enough to maintain a high level of humidity. Condensation droplets should appear on the tank glass. Place the tank near an outside window or alternate daily periods of light and darkness, so that photosynthesis occurs.

9. Every two weeks, feed insects to the carnivorous plants. (Don't overfeed.)

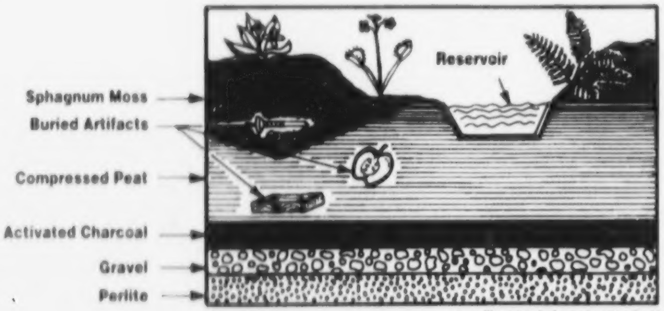


Illustration by Laurie "gigette" Gould

Bog construction is adapted from "The Vanishing Bog" by Muhammad Hanif, NSTA Publications, copyright 1990 from Science and Children [illegible]. National Science Teachers Association, 1840 Wilson Boulevard, Arlington, VA 22201-3000.

GUIDE TO ACTIVITY 26

Feeling the Heat Makes My Molecules Dance

◆What is happening?

When water evaporates, it changes from a liquid to a gas. This change of state requires an input of energy. Water can obtain this energy from a warm surface or by absorption of electromagnetic energy (such as sunlight).

Warming the blackboard with the lamp provides a source of heat energy for the water placed on that area. This energy makes the molecules of water placed on the warm spot move more rapidly than the water molecules placed on the cool section of the blackboard. The warmer area of blackboard dries first.

◆Time management

Allow 20 to 30 minutes to perform this activity and discuss it.

◆Preparation

Clamp lamps work well for this activity.

Bulbs larger than 100 watts get extremely hot and are not recommended for use in this activity.

The blackboard only needs to be slightly warm to the touch before the water is placed on it. A hair drier set on "high" can be used to warm the area of blackboard instead of a light bulb. If you do not have a blackboard, or if the blackboard that is available will be harmed by heat or water, press the sponges on a piece of smooth masonite or use cardboard.

◆Suggestions for further study

Ask the students if a fan will cool or warm the area. Then ask them to predict what will happen based on their observations from the previous experiment. Now repeat the experiment while fanning the warm area with a piece of paper. Explain that the fan moves water-saturated air away from the board, which allows unsaturated air in near the board, thereby increasing the rate of evaporation. Evaporation absorbs heat which lowers the temperature.

◆Answers

4. Answers will vary, but most students will probably predict that the water in the heated location will evaporate first.

Water molecules are always in motion. The speed with which they move depends on the temperature of the water—the higher the temperature, the faster the molecular motion. The water placed on the heated area absorbs heat from the blackboard; its molecules begin moving faster than the water on the unheated area. The faster-moving molecules on the heated area are more likely to escape from the blackboard by overcoming the **cohesion** that holds them to the other water molecules and the **adhesion** that holds them to the board. Therefore, the water disappears from the heated area first.

Sample data

The water in the heated area disappeared in *one* minute.

The water in the unheated area disappeared in *four* minutes.

Note: These times will vary depending on the temperature of the heated area of blackboard compared to room temperature, the amount of water in the wet spots, and the relative humidity of the room. The evaporation times may range from 30 seconds to 3 minutes for the warm area, and from 1 to 5 minutes for the cool area.

The Ways of the Watersheds

Frost Valley YMCA
2000 Frost Valley Road
Claryville, New York 12725-9600
(914) 985-2291

🌧 🌧 🌧 🌧

$20.00 and $5.00 shipping. 1995. 248 pages.

"The Ways of the Watersheds, an Educator's Guide to the Environment and Cultural Dynamics of New York City's Water Supplies" examines several aspects of watersheds, associated problems, and possible solutions. Activity sections include: The Hydrology of the Watersheds, The Geology of the Watersheds, The Ecology of the Watersheds, The Pollution Sources of the Watersheds, The Development Within the Watersheds, The Technology of the Watersheds, and Conserving the Quantities of the Watersheds. Two appendices and extensive bibliographies are provided. Although specific to New York, activities can be modified to work elsewhere.

REPORT CARD

Overall Grade	A
General Content	A
Presentation	A-
Pedagogy	A
Teacher Usability	A-
Water Resources	A

COMMENTS

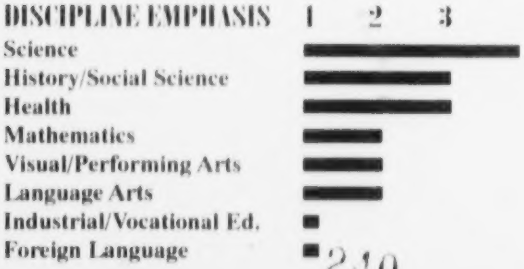
General Content
"Excellent, in-depth background materials, broad scope, and a good level of detail for grades 7 - 9."

Presentation
"Very nice layout and graphic presentation."

Pedagogy
"A truly integrated approach." "Fun and diverse activities."

Teacher Usability
"This offers an extensive resource guide."

Specific Content on Water Resources
"Strong in promoting water stewardship." "A thorough coverage of water resources issues."



One In A Billion

Grades: middle and upper
Objective: to illustrate the magnitude of the concentration - parts per billion
Subjects: Life Sciences, Chemistry, Math, Social Studies

Materials: 3 one-liter beakers or plastic bottles, food coloring, graduated eye dropper, graduated beaker or cylinder for measurement or volumes, water, paper and pencil, calculator (optional)

Information:

One part per billion (ppb) of almost anything seems like a minuscule amount that often seems too small to even comprehend. If you look at one part per billion share of a square mile piece of land, it would only amount to 2 square-inches of soil.

On the other hand, one part per billion can seem like a lot if the number is measuring dangerous substances like toxins that do not need to be present in large amounts to do significant damage. For example, the volume of water in the Chesapeake Bay and its estuarine tributaries equals approximately 74 million acre-feet. If the following contaminants were present in that volume of water at one part per billion level, they would represent enough raw material to:

- cast 25,000,000 lead bullets
- plate 1.25 million car bumpers with chromium
- fill 100,000,000 medical thermometers with mercury
- fill 125,000,000 aerosol cans of bug killer with insecticides

Of course, in reality, concentrations of these substances vary from place to place in the Bay. So called "hot spots" often have concentrations greater than 1 ppb, but in most areas of the Bay concentrations are less than that. Further monitoring is needed to determine exactly what loads of toxins are present. (The Chesapeake White Paper, August 1988)

This series of experiments and mathematical problems will demonstrate to your students the volume involved in these minute measurements.

Procedures:

1. After discussing scientific studies that view water contamination by toxins, note the measurements of one part per billion (ppb) and one part per million (ppm). Begin these experiments by explaining to your students that they will be doing a serial dilution to get to know these minute values.
2. Start with each of the three bottles containing 999 milliliters of clean water.
3. To Bottle #1, add 1 ml of food coloring (approximately 20 drops) to represent the pollutant. Note and record the color of the bottle's water. Ask your students to calculate the volume of this bottle: 999 mls of clean water + 1 ml of pollutant which equals 1,000 mls of contaminated water. Next, have them calculate and record the dilution of this bottle: 1 ml of pollutant per 1,000 mls of water = 1 part pollutant per thousand parts water.

242

4. To Bottle #2, add 20 drops from Bottle #1 and mix well. Note and record the color change in the bottle's water. Ask your students to calculate the volume of this bottle which should also be 1,000 mls. Next, have them calculate and record the dilution of this concentration: 0.001 mls of pollutant per 1,000 mls of water equals 1 part pollutant per million parts water.
5. To Bottle #3, add 20 drops from Bottle #2 and mix well. Note and record the color change in the bottle's water. Ask your students to calculate the volume of this bottle which should also be 1,000 milliliters. Next, have them calculate and record the dilution of this concentration: 0.000001 mls of pollutant per 1,000 mls of water equals 1 part pollutant per billion parts water.

Variations:

- Mathematics can take on a fun dimension when the students use it to calculate just how far apart one million and one billion really are. Some useful figures in setting up a math lesson around these numbers are:

  A stack of U.S. paper currency one inch high will contain 233 bills. If you had a million dollars in thousand dollar bills, the stack would be 4.29 inches tall. If you had a billion dollars in thousand dollar bills, the stack would be 357 feet tall or almost the length of a football field. (Access, May/June 1994)

  If you were traveling on the Concorde, you would be able to circle the globe in only 18.5 hours (at a cruising speed of 1,340 miles per hour). At that speed, it would take the Concorde 746 hours or 31 days to travel one million miles. At that speed, it would take the Concorde 31,094 days or 85 years to travel one billion miles. (Access, M/J 1994)

  1 inch in 16 miles = 1 part per million

  1 drop of water in an Olympic-sized swimming pool = 1 part per billion

  1 drop of water in a railroad tank-car = 1 part per billion

  Assuming that a person could count non-stop at an average of 2 seconds per number, it would take someone about 23 days to count to one million.

- Another math lesson in understanding what "parts per" means is to have your students calculate what part of their surroundings they constitute. Start with the statements:
  There are _____ people in your family. There is only one you.
    This means that you are one part per _____ in your family.
  There are _____ students in your class. There is only one you.
    This means that you are one part per _____ in this class.
  Continue on using increasingly broader and larger groups.

- For a two week period, try to collect one million of an item (i.e. buttons, soda can tabs, pennies). Keep the items small and also keep in mind creative ways of disposing of the items at the end of the time period (i.e. fund raiser, recycling, garden or art projects).

Watershed Discussion Questions:

- How would you know if the pollutant were in surface or groundwater reservoirs?
- Why is it important to know about these small amounts of chemicals?
- Is the solution to this pollution dilution?

Sources: Activities are adapted from *New Adventure* in My World, My Water and Me and *Demonstration: Serial Dilution - Parts Per Billion* in Hidden Treasure

243

San Diego: World in Harmony

I Love a Clean San Diego County, Inc.
7907 Ostrow Street, Suite F
San Diego, California 92111
(619) 467-0103

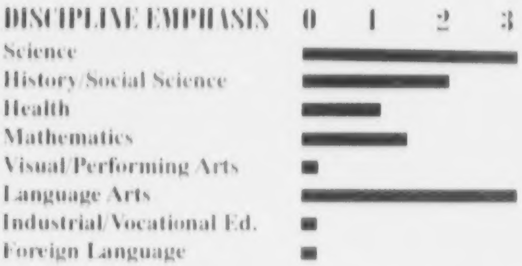
🌧 🌧 🌧 🌧

$20.00 (includes shipping). 1994. 496 pages.

Issues surrounding waste disposal, waste reduction, and resource recovery are explored through numerous interdisciplinary activities. Five of 15 units specifically address water issues, including polluted urban runoff, sewage, water conservation, and water reclamation. Extensive background information, extended challenges, recommended adaptations for special education, and cross-referencing by subject are provided.

REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	A-
Teacher Usability	A-
Water Resources	A-



COMMENTS

General Content

"A good general environmental studies curriculum." "Uses contemporary environmental education philosophy and principles to promote awareness, knowledge, and action."

Presentation
Cultural diversity is represented well in photographs. "Good layout - easy to read."

Pedagogy
"Assessment tools could be stronger." "Activities offer a variation for students with special needs." "Emphasizes process skills." "A variety of instructional strategies are offered."

Specific Content on Water Resources "Issues are San Diego-specific." "Details California water conflicts." "Surprisingly thorough on often-ignored water topics: sewage treatment, urban run-off, and ocean dumping."

"What 'Runs Off' the School Grounds?"

A Science/Math Activity

Summary:

The students read the sections in the overview that explain how watersheds, which absorb rainwater in natural circumstances, do not exist in urban environments, a situation that causes "polluted urban runoff." Next, they work in teams to estimate percentages of the surface of the school grounds in two categories: those that absorb rainwater and those that deflect it. Both categories are segmented further by subcategories (lawns, gardens, playgrounds, walkways, roofs, asphalt surfaces, etc.) with percentage estimates. The teams use any method they choose to develop their estimates. Then they develop bar graphs showing their estimates for each surface category and its subcategories. Finally, each team presents its graphs to the class and explains how estimates were derived.

Procedure:

1. **Prior to class.** Read the summary for this activity and the overview for this unit.

Primary Goal:
To give students "hands-on" understanding of the functions of a natural watershed and how the absence of a watershed creates runoff

Content Objectives:
Students will learn that

- Natural drainage systems that allow rainfall to move downstream and become filtered and purified while flowing to the ocean are called "watersheds."
- Water which is not filtered through a watershed and instead collects in urban storm drains is not purified. Such water also picks up additional pollutants in the city, thus poisoning the beaches and bays it flows into

Process Objectives: To enable students to develop and utilize the following skills/abilities:

Framework Connections:
Analysis of cause and effect
Reaching conclusions based on observations
Determining responsibilities of humans toward ecosystems
Utilizing written and oral communication

CLAS Connections:
Estimating measurements
Observing natural processes
Communicating and inferring descriptions of natural processes

Time Needed:
Three class sessions: the first to form teams, plan strategies and begin estimating, the second to continue estimating and to create graphs, the third session devoted to team reports

Materials/Preparations Needed:
A copy of a map of your school, including the grounds, for each student (if available); three pieces of poster paper per team for bar graphs; strips of colored paper and magic markers; one measuring tape per team; one copy of the following segments of the overview for each student: "What Causes Polluted Urban Runoff?," "Don't Go Swimming or Surfing After a Rainstorm!" and "Long Term Effects."

Extended Challenges:

Suggest that the students extrapolate this activity regarding the school grounds to other areas, such as their homes and yards, a nearby shopping center, the neighborhood, community, the entire county, etc. Provide extra credit for individual and team efforts that demonstrate reasonable estimates with results shown on bar graphs.

Obtain geological maps of San Diego County showing natural waterways and the watersheds which feed into them. Challenge the students to find out, through personal observation and consultation with county officials, which watershed areas and waterways have largely retained their natural state and which have been heavily altered by urban development. Allow the students to report their findings to the class.

Find out if the students have experienced the other activities in this unit, and if not, provide them with the final segment of the overview, "How Can We Help Solve the Problem?" Discuss with the class each suggestion contained in this segment.

Special Education Adaptations:

Please refer to "Adaptations for Students with Special Needs," pages 8-13, for recommendations concerning how to address the requirements of students with disabilities.

Student Evaluation:

Criteria for evaluating student performance may include these possibilities:

- Quality of contribution to team effort in estimating surface areas, creating bar graphs and reporting results to the class.

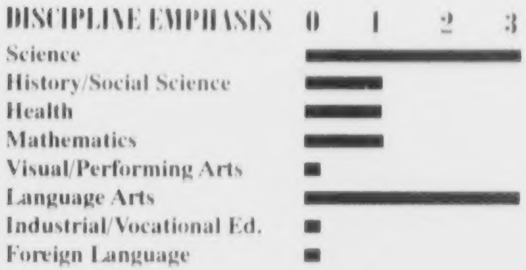
Important: Clearly state these criteria to students at outset of activity.

Earth, the Water Planet

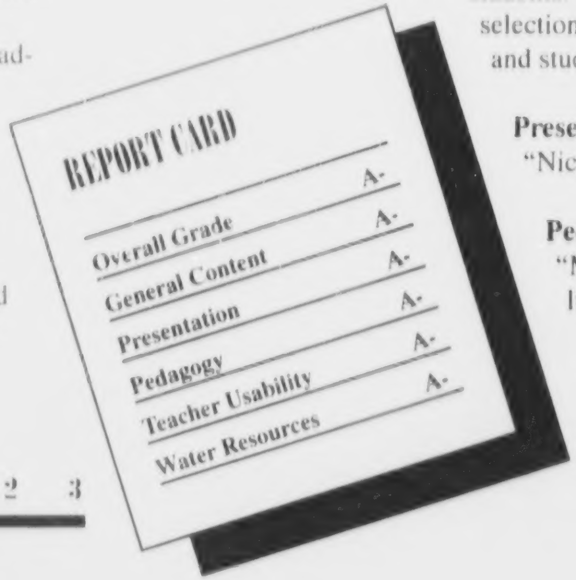
National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3000
(800) 722-6782

$18.50. 1992. 204 pages. Item PB076X.

Instructional modules and selected readings provide in-depth learning on water and hydrology. Modules focus on groundwater, the earth's surface, rainfall, the distribution of water, and the physical properties of water. The book also includes a master list of materials, recommended audiovisual materials, metric conversions section, and a glossary.



☁ ☁ ☁ ☁



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	A-
Pedagogy	A-
Teacher Usability	A-
Water Resources	A-

COMMENTS

General Content
"A comprehensive resource on water with reading materials for students." "A well-rounded earth science unit on water." "A good selection of readings for background - suitable for both teachers and students."

Presentation
"Nice layout and worksheets."

Pedgogy
"Material is easily integrated into an established curriculum." "Assessment tools are not provided."

Teacher Usability
"Easy to use and very complete."

Specific Content on Human Communities
"Strong section on the physical properties of water." "A lot of information on groundwater and water problems associated with agriculture."

248

249

ACTIVITY 26 WORKSHEET

Feeling the Heat Makes My Molecules Dance

Materials

Each group will need
- an area of blacsboard
- an electric lamp with a 100 watt bulb
- 2 sponges
- a container of water

Vocabulary

- **Adhesion:** The attraction between molecules that causes matter to cling or stick to other matter (as adhesive tape).
- **Cohesion:** The ability of a substance to stick to itself and "pull itself together."

Keep the electric lamp away from water!

◆Background

When temperature increases, the molecules in a substance move faster. Will increasing the temperature make it easier for water to undergo a change of state?

◆Objective

To explain how temperature affects the rate at which water changes state.

◆Procedure

1. Place the lamp as close as possible to the blackboard and turn it on. Leave the bulb burning until an area of the surface of the blackboard about 20 cm in diameter is warm (*not* hot) to the touch. (This may require three to five minutes—check the blackboard after a few minutes and see if it feels warm.)

2. When the board is warm, turn off the lamp and move it away from the blackboard. Moisten the sponges and squeeze out any excess water. Both sponges should be equally damp. No water should drip from them.

3. At the same time, press one sponge against the warm spot on the blackboard and the second sponge against an area that was not warmed by the lamp.
Both sponges should leave damp "footprints" on the board, but very little water should run down from the damp spots.

4. Your prediction: Which wet spot will disappear first—the one on the heated area of the board or the one on the unheated area? Explain your prediction in terms of the motions of the water molecules escaping from the blackboard.

5. Which wet spot disappeared first? How accurate was your prediction?

250

GUIDE TO ACTIVITY 26

Feeling the Heat Makes My Molecules Dance

◆What is happening?

When water evaporates, it changes from a liquid to a gas. This change of state requires an input of energy. Water can obtain this energy from a warm surface or by absorption of electromagnetic energy (such as sunlight).

Warming the blackboard with the lamp provides a source of heat energy for the water placed on that area. This energy makes the molecules of water placed on the warm spot move more rapidly than the water molecules placed on the cool section of the blackboard. The warmer area of blackboard dries first.

◆Time management

Allow 20 to 30 minutes to perform this activity and discuss it.

◆Preparation

Clamp lamps work well for this activity.

Bulbs larger than 100 watts get extremely hot and are not recommended for use in this activity.

The blackboard only needs to be slightly warm to the touch before the water is placed on it. A hair drier set on "high" can be used to warm the area of blackboard instead of a light bulb. If you do not have a blackboard, or if the blackboard that is available will be harmed by heat or water, press the sponges on a piece of smooth masonite or use cardboard.

◆Suggestions for further study

Ask the students if a fan will cool or warm the area. Then ask them to predict what will happen based on their observations from the previous experiment. Now repeat the experiment while fanning the warm area with a piece of paper. Explain that the fan moves water saturated air away from the board, which allows unsaturated air in near the board, thereby increasing the rate of evaporation. Evaporation absorbs heat which lowers the temperature.

◆Answers

4. Answers will vary, but most students will probably predict that the water in the heated location will evaporate first.

Water molecules are always in motion. The speed with which they move depends on the temperature of the water—the higher the temperature, the faster the molecular motion. The water placed on the heated area absorbs heat from the blackboard; its molecules begin moving faster than the water on the unheated area. The faster moving molecules on the heated area are more likely to escape from the blackboard by overcoming the **cohesion** that holds them to the other water molecules and the **adhesion** that holds them to the board. Therefore, the water disappears from the heated area first.

Sample data

The water in the heated area disappeared in *one* minute.

The water in the unheated area disappeared in *four* minutes.

Note: These times will vary depending on the temperature of the heated area of blackboard compared to room temperature, the amount of water in the wet spots, and the relative humidity of the room. The evaporation times may range from 30 seconds to 3 minutes for the warm area, and from 1 to 5 minutes for the cool area.

GRADES 7-9

BEST COPY AVAILABLE

251

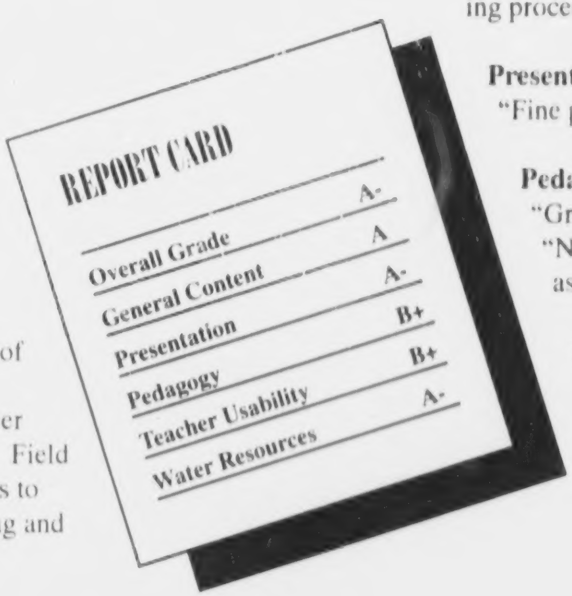
Hands On Save Our Streams

Save Our Streams
The Izaak Walton League of America
707 Conservation Lane
Gaithersburg, Maryland 20878
(800) 284-4952

$18.00. 1995. 201 pages

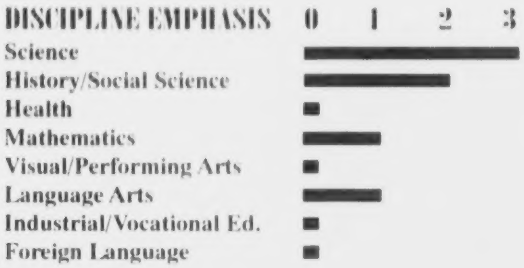
🌧 🌧 🌧 🌧

This teacher's manual is based on the grassroots river and stream protection program of the Izaak Walton League of America. Classroom activities integrate science, social science, language arts, and mathematics to introduce the concept of watershed, the hydrologic cycle, the relationship between land use and water quality, and water quality monitoring. Field trips provide opportunities for students to apply skills in water quality monitoring and restoration activities.



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	B+
Teacher Usability	B+
Water Resources	A-



COMMENTS

General Content

Excellent coverage of watershed and stream health, water monitoring procedures, and stream-based community action projects.

Presentation

"Fine pictures and diagrams."

Pedagogy

"Great application of learning with the use of field studies." "Needs less worksheet-based activity and more authentic assessment."

Teacher Usability

"Field study lessons are great; however, if a nearby stream is not readily accessible, many lessons would be hard to adapt." Excellent background information. "Describes how to use the curriculum across the disciplines." "This requires an extensive list of equipment."

Specific Content on Water Resources

"A comprehensive guide to water-related issues." Addresses the controversy of land use versus water quality.

253

252

Field Activity #1

Stream Doctors

Lesson Time: 1 1/2 to 2 hours*

SOS is primarily a biological monitoring program. However, chemical monitoring also can be conducted if the class has chemical monitoring kits. Chemical monitoring should be done at the same time or within a few days of biological monitoring because water chemistry may change daily and hourly. As noted in the introduction, chemical monitoring may miss a pollutant in the stream because the monitoring kit may not include tests for that particular substance. Also, if a pollutant passed through the stream earlier and harmed aquatic life, it may not show up in a chemical test taken days later. However, stream critters will show a disturbance in their populations if the chemical was toxic to them.

Objective: Students will visit the stream to conduct their monitoring project. They will learn if the water quality they guessed in class is the actual water quality of their stream.

---

*Save time by taking samples back to class in a sealed plastic container. Keep refrigerated overnight and identify the macroinvertebrates the next day. You can answer questions on the SOS survey form about the stream on the next day, but they should be answered at the stream during a return visit.

Discussion Questions for Stream Doctors:

1) What was the water quality rating for the stream: excellent, good, fair or poor?

2) Was the stream as clean as you thought it would be?

If not, why?

3) What problems might be causing stream pollution?

4) How can you pinpoint the source of a problem by monitoring?

5) Do you think that the water quality of the stream today is the same as it was before no people lived in the area?

What effects do people have on streams?

6) How can people fix pollution problems now so the stream will be clean for future generations?

7) Guess what will the stream be like in the year 2000.

BEST COPY AVAILABLE

Always a River

United States Environmental
Protection Agency
Attn: Helen Fischer
Office of Research and Development
26 West Martin Luther King Drive
Cincinnati, Ohio 45268
(513) 569-7781

No charge. 1991. 284 pages.
Quantities are limited.

"Always a River, a Supplemental Environmental Education Curriculum on the Ohio River and Water" offers a series of activities that focus on the Ohio River and its importance to the six states through which it flows. Four broad units explore the Ohio River in relation to the total ecosystem; the biological, physical, and chemcial aspects of water; human use of and impact on the Ohio River; and historic influence and implications of the Ohio River. Although regional in focus, activities can be modified to work elsewhere.

🌧 🌧 🌧 🌧

REPORT CARD

Overall Grade	A-
General Content	A
Presentation	B+
Pedagogy	A-
Teacher Usability	B+
Water Resources	A

COMMENTS

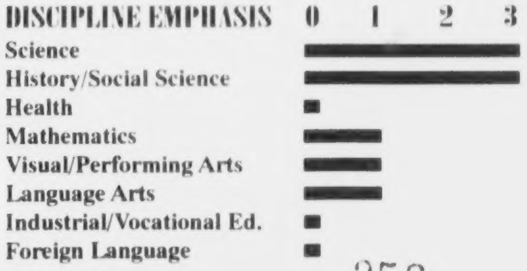
General Content
"This is a comprehensive curriculum on the Ohio River... a multicultural emphasis weaving Native American cultures into the social sciences."

Presentation
"Easy to use format." Needs diagrams to support activities.

Pedagogy
A variety of lab activities. "A K - 12 sequential curriculum."

Teacher Usability
"Although regional, this material is adaptable to California for those who take the time." "Good interdisciplinary cross-references." "Lots of resources and information."

Specific Content on Water Resources
"A wide-range approach to water issues - geology, history, social concerns, etc. regarding the Ohio River." "Great breadth on water treatment; strong physical science and economics component."



Activity

In Hot Water

Objective Students will study the relationship between water temperature and density, define a thermocline, and discuss the ecological significance of stratification and mixing.

Setting Classroom

Duration One 40- to 60-minute period

Subject Chemistry, Mathematics, Science

Skills Comparing Similarities and Differences, Discussion, Evaluation, Observation, Psychomotor Development, Small Group Work

Grade Level 6-10

Vocabulary density stratification thermocline

Background Information Refer to Unit II, Sections B-5 and B-7.

Materials

For the class:

- Hot tap water.
- Cold water (from refrigerator or ice water). If you don't have access to a refrigerator, plan to do this activity early in the morning and bring ice cubes from home. If you do not have an ice chest, put the ice cubes into watertight plastic bags and wrap them in newspaper.

For each group:

- Four clear plastic cups.
- A plastic spoon.
- A bottle of food coloring.

Procedure

1. Divide the class into groups of three or four. Give each group four clear plastic cups, a plastic spoon, and a bottle of food coloring.
2. Ask each group to fill two of its cups with hot tap water (but not so hot that it could burn a child's skin) and the other two with cold water, and to take these cups back to their workstations.

Procedure *(continued)*

3. At their workstations, ask the students to add a few drops of coloring to one of the hot water cups and one of the cold water cups. Next, ask the students to take a spoonful of the cold colored water and very carefully pour it on the surface of the hot clear water. Observe what happens. (The cold colored water, which is denser than the hot clear water, should sink.)
4. Now, ask the students to try the reverse. Take a spoonful of hot colored water and pour it on the surface of the cold clear water. What happens? (The hot water should float on the surface of the cold water because it is less dense.)

Note: As a control, you might demonstrate to students what happens when a spoonful of hot colored water is added to a cup of clear hot water, and when a spoonful of cold colored water is added to a cup of cold clear water.

5. Discuss how a body of water can be stratified, or layered, with two totally different kinds of places (in terms of temperature) for plants and animals to live. Ask students if they know what the zone between the two layers (warm and cold) is called? (A thermocline.) Ask students if they have ever noticed a sharp drop in temperature while swimming in a lake or pond, and explain that this is the thermocline.
6. Ask the students to stir the water and observe what happens (the water becomes mixed). Discuss what "stirs" real water (wind). Discuss why mixing is ecologically important in a body of water (for example, provides oxygen, helps transport nutrients).

Note: You might want to try this activity at home before conducting this experiment in the classroom. It may be difficult to add the spoonful of water so that the proper layering occurs. If so, another simple way to demonstrate the principles of this lesson is to fill a small balloon with very cold water (place a water balloon in the refrigerator) and drop it into an aquarium filled with hot water. Observe whether it sinks or floats (it should sink). Leave the balloon in the water and observe what happens when it warms up (it rises).

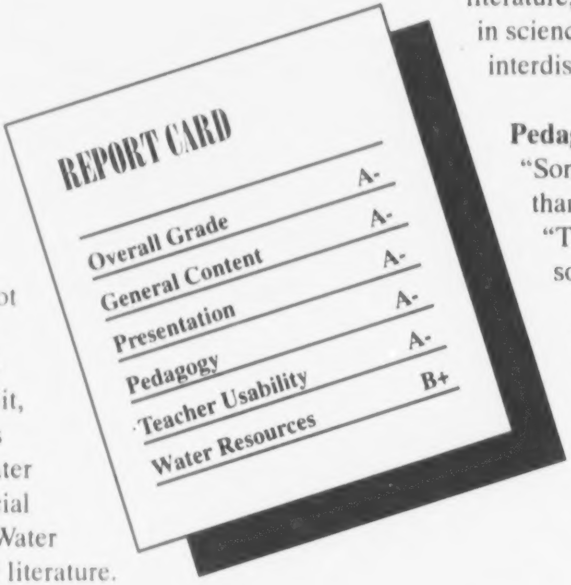
Extension/ Evaluation Investigate what happens when a pond or lake freezes by having the students make a model pond. Fill a plastic cup with cold water. Put several Styrofoam® cups inside one another and then place the plastic cup inside the Styrofoam® cups (the Styrofoam® will help insulate the plastic cup). Check the cup every 15 minutes. Where does the ice form first? Record when the ice forms and where. If a pond works in the same way, where does the ice form first? (Do not try to freeze the water in the cup solid as it may burst.)

Water Wisdom

Alameda County Office of Education
313 West Winton Avenue
Hayward, California 94544-1198
(510) 887-0152

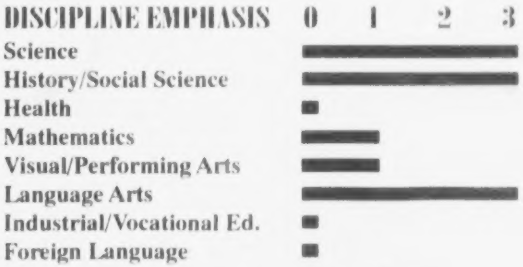
$14.50. 1990. 119 pages.

"Water Wisdom" is the second supplement to the *California State Environmental Education Guide*. It consists of three instructional units for grades 4 - 8. The focus of the units is on expanding students' thinking to view water as important, not only for human consumption, but also for the survival of all living organisms and the planet as a whole. The first unit, "Water Nurturing Nature," emphasizes science concepts; the second unit, "Water Rights and Responsibilities," has a social studies emphasis; and the third unit, "Water Symbolism," focuses on cross-cultural literature. The California Water Map is included.



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	A-
Pedagogy	A-
Teacher Usability	A-
Water Resources	B+



COMMENTS

General Content

Good, interdisciplinary treatment of water through symbolism, literature, and social studies. "This could be used as a supplement in science, or as a beginning point in the development of an interdisciplinary unit."

Pedagogy

"Some activities are more appropriate for elementary, rather than middle school use."

"This is closely aligned with state frameworks in history-social science, language arts, and science."

Teacher Usability

"Could easily be modified for use through grade 12." Rich in myths, legends, and other language arts components. "Well named ...'Water Wisdom.'"

Specific Content on Water Resources

Good specific information on California water rights.

LESSON 4

WHO'S RESPONSIBLE FOR WATER?

SUMMARY OF ACTIVITY

Students rate five people according to who they think is most responsible for a polluted lake. Because there is no clear answer, students gain insight into some of the complexities of water ownership and responsibility.

Time: One 45-minute activity period

Materials:
- Scratch paper for each student
- Copycat pages: one set per group of four students
- Blank paper: per group of four students
- Marking pens: one set per group of four students
- Butcher paper
- One recording pen

BACKGROUND INFORMATION

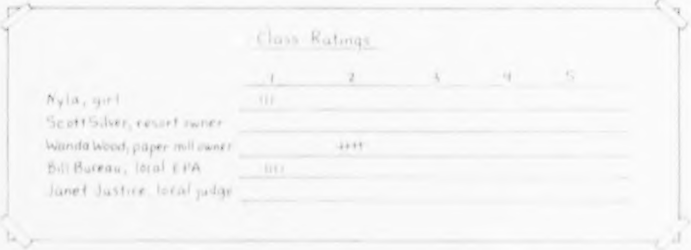
Besides water *quantity*, the biggest issue in California water is water *quality*. For decades, Californians took for granted high-quality, uncontaminated drinking water. Groundwater, in particular, was considered safe from pollution because people long believed that soil would filter out any contaminants. Unfortunately, we now know that soil does not filter contaminants, and scientists have discovered traces of industrial solvents and pesticides in groundwater supplies throughout California.

To protect people from water pollution, the federal Safe Drinking Water Act requires water suppliers to test for various compounds in drinking water. In addition to this act, in 1986, Californians overwhelmingly passed the Safe Drinking Water and Toxic Enforcement Act of 1986 (known as Proposition 65). This ballot initiative bans companies from deliberately releasing into the environment substances that are known to cause birth defects or cancer.

One difficulty in monitoring water quality is knowing and containing the source of the pollution. Another difficulty is resolving who is responsible for the pollution and for mitigating its harm. In this activity, students grapple with a situation in which there is no clear answer to who is responsible. They also consider what the situation reveals about water ownership.

PREPARATION AND LEAD-UP

On the butcher paper, make a class chart for recording the students' ratings, as in the following illustration.



Class Ratings

	1	2	3	4	5
Nyla, girl	|||				
Scott Silver, resort owner					
Wanda Wood, paper mill owner		||||			
Bill Bureau, local EPA	||||				
Janet Justice, local judge					

Bill Bureau is the head of the local EPA in Riverdale. He says he would like to make the paper mill install better pollution control devices but that he cannot do so because he does not have the support of the local judge. Without the support of the local judge, he says he has no power to force the paper mill to do anything.

Janet Justice is the local judge in Riverdale. She says that the paper mill provides more jobs than any other business in the area. She says that a better pollution-control system would be very expensive and that forcing the mill to put one in would cause it to shut down. She says this would seriously affect the people in the area.

Questions

1. Draw a picture of the river showing each of the five people and their positions.

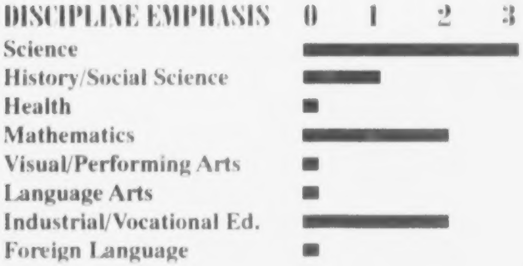
2. Discuss with your group members who you think is most responsible and why.

The Stream Scene

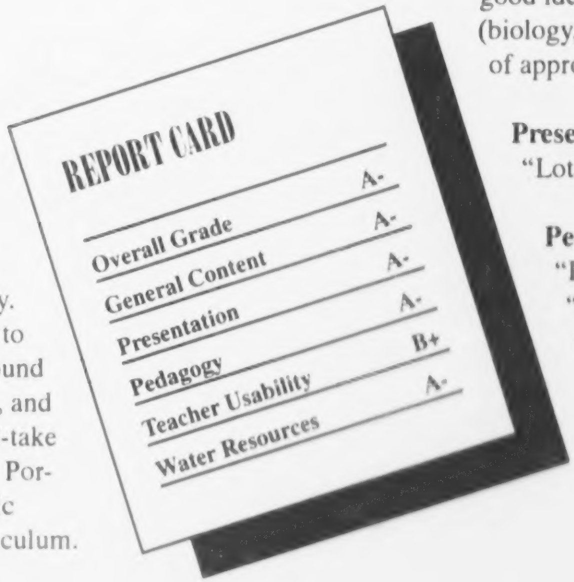
Oregon Department of Fish and Wildlife
Office of Public Affairs
P.O. Box 59
Portland, Oregon 97207
(503) 872-5264

$15.00. 1992. 208 pages.

"The Stream Scene - Watersheds, Wildlife and People" provides an overview of watershed systems, specifically watersheds and riparian ecosystems, the water cycle, hydrology, water quality, and aquatic biology. Activities ultimately prepare students to conduct field investigations. Background information, reproducible worksheets, and five appendices including a make-and-take field equipment section are included. Portions of "Project WILD" and "Aquatic Project WILD" complement this curriculum.



🌧 🌧 🌧 🌧



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	A-
Pedagogy	A-
Teacher Usability	B+
Water Resources	A-

COMMENTS

General Content
A very thorough approach to study aquatic environments with "good ideas for stream improvement projects." "More science (biology, geology) than environmental education." "Presents lots of appropriate, but challenging technical detail."

Presentation
"Lots of graphs and tables."

Pedagogy
"Designed for a rural setting ... and at times technical." "Evaluation is based on recall of facts." Although assessment is not included, "some activities could serve as assessment tools."

Teacher Usability
"Good teacher information - good student materials." Helpful appendices.

Specific Content on Water Resources "Excellent in an aquatic community." "May be hard to apply to Southern California." Some material is Oregon-specific, but could be adapted. "A 'Fish and Game Department slant' when dealing with controversial issues such as dams and fisheries."

Name

Does the earth wear a raincoat?

Do you know . . .

what a watershed is? If you stood in a streambed and looked upstream at the entire land area the stream drains, you would be looking at the stream's watershed. Every body of water, be it stream, lake, pond, river or mud puddle, has a watershed.

Watersheds can be big or small. A mud puddle has a watershed of only a few square feet, while the Columbia River watershed has 258,000 square miles! A raindrop, no matter where it falls in this entire watershed (unless it evaporates), will end up at the mouth of the Columbia River at Astoria. Most large watersheds are made up of many smaller watersheds. For instance, the Columbia watershed includes the Snake, John Day, Deschutes, Umatilla, and Willamette watersheds, as well as many others.

You live on a watershed, as do all people. Almost all of the area of a watershed is made up of land, not water. Ninety-nine percent of what happens to a stream actually takes place on the land area of the watershed. It does not happen in the stream itself. So, every activity in a watershed could affect the nearest stream and the entire downstream part of the watershed.

Columbia River Basin

Source: Ed Chaney, *A Question of Balance: Water/Energy—Salmon and Steelhead Production in the Upper Columbia River Basin Summary Report*, Nov. 1978. NW Resource Information Center, Inc.

Now it's your turn . . .

How big is a watershed? Where does one watershed end and another begin? In this activity, you will answer these questions by outlining an eastern Oregon and a western Oregon watershed on the maps provided.

- On the Umatilla Drainage Basin map (p. 39), find Rhea Creek (Rhea Creek empties into Willow Creek from the south at Jordan, two miles east of Ione.) Outline the Rhea Creek watershed on your map.
- On the Mid-Coast Drainage Basin map (p. 40), find a stream called Five Rivers (Five Rivers runs through the communities of Denzer, Fisher and Paris southeast of Waldport. Locate the place where Five Rivers empties into the Alsea River.) On the map, outline the Five Rivers watershed.

Questions

1. Describe a watershed in your own words.

2. The water in Willow Creek at Ione comes from the Willow Creek ____________

3. Give two examples of how natural or human-influenced events could affect a watershed.

4. An intermittent stream is a stream that does not flow year-round. These streams are shown on the maps as lines separated by dots. List as many reasons as you can why streams do not flow year round.

5. How would fish be affected by intermittent flow?

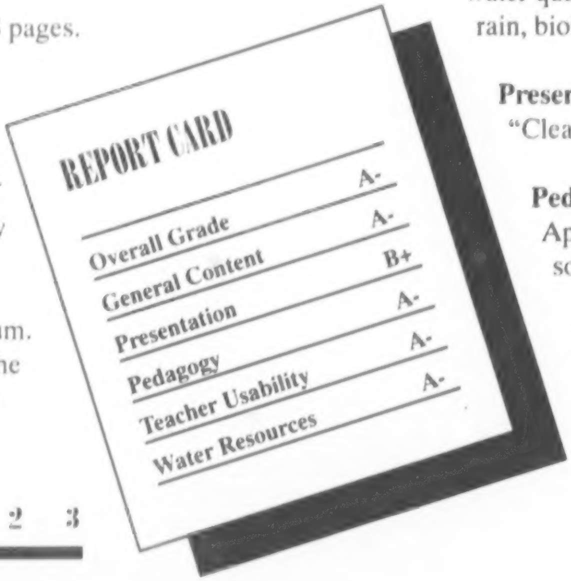
6. How would wildlife living near the stream be affected by intermittent flow?

Water Champs, Water Quality in the Champlain Drainage Basin

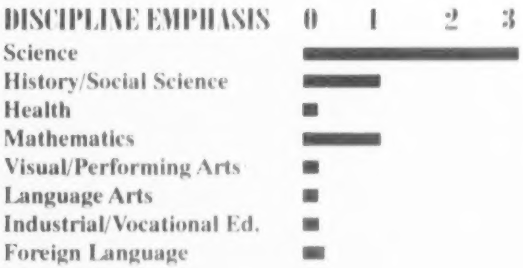
The Adirondack Park Visitor Centers
Rte. 30, Box 3000
Paul Smiths, New York 12970-3000
(518) 327-3000

No charge. 1985 (revised in 1995). 88 pages.

"Water Champs" is a science unit on hydrology, water pollution, and the scientific method. Following a three week classroom investigation of the properties, quality, and availability of water, students monitor a local stream and present their findings to peers at an informal science symposium. Although Water Champs focuses on the Lake Champlain Drainage Basin, it is easily adaptable to other regions.



REPORT CARD	
Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	A-
Water Resources	A-



COMMENTS

General Content
"A good water curriculum sequence - very complete." "Offers good water quality monitoring activities... thorough development of acid rain, biological oxygen demand, and dissolved oxygen."

Presentation
"Clear graphics."

Pedagogy
Applies computer skills through use of accompanying software. "Offers meaningful activities."

Teacher Usability
"Good, concise, and easily understood writing." "Easy to use." "A nice supplement to an existing curriculum." This does require having a lake or river nearby to fully implement the program.

Specific Content on Water Resources
"Good section on topographic maps and watersheds." "Although about the Champlain Drainage Basin, it is very easily adaptable."

Getting to Know Your Watershed: TOPOGRAPHY

Objective

Students will:

A. Understand use of contour lines, elevation and basic topographic features.

B. Be able to locate a watershed on a map.

Materials

Pencils, pens or highlighters

Time

20 to 30 minutes

Activity Description

1. Mark the highest point on the map with an X.
2. Mark the lowest point on the map with an O.
3. Find a stream or river on the map—use arrows to show which way the water flows.
4. Trace the path of rain that falls on the highest point on the map show how it would flow to the lowest point on the map.

Define:

contour line________________________________

____

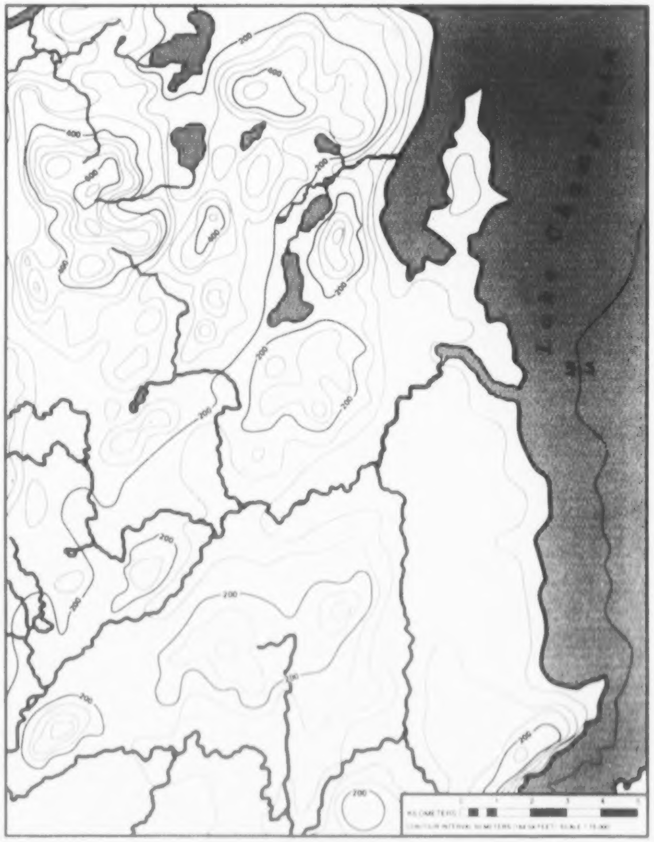
elevation__________________________________

____

sea level__________________________________

____

Getting to Know Your Watershed: TOPOGRAPHY cont.

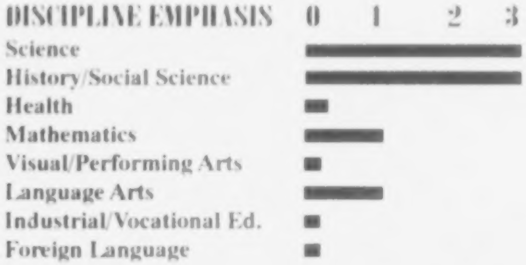


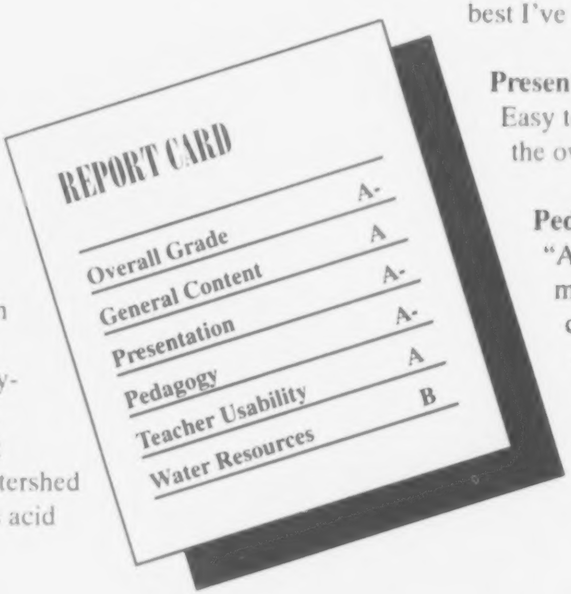
California CLASS Project

California Department of Education
Bureau of Publications, Sales Unit
P.O. Box 271
Sacramento, California 95812-0271
(800) 995-4099

$28.00. 1984. 374 pages.

The "California CLASS Project" is an interdisciplinary program that integrates science, social science, and language arts. Students are presented with real-life environmental issues facing California, which are explored and discussed through a variety of interactive activities. Thirty-nine activities revolve around energy, hazardous substances, wildlife habitat management, wetlands, forest and watershed management, and other issues such as acid rain and solid waste.





REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	A-
Teacher Usability	A
Water Resources	B

COMMENTS

General Content
"Outstanding linkage with land use planning issues." "One of the best I've seen: great background, diagrams, lesson plans."

Presentation
Easy to use format. "Illustrations need improvement." "Some of the overheads are outdated."

Pedagogy
"Aligned to the state frameworks." "Good discussion-making and genuine biological inquiry." "Emphasizes cooperative learning, critical thinking and problem-solving skills."

Teacher Usability
A very useful supplement.

Specific Content on Water Resources
"Discusses socioeconomic and environmental quality issues... although water is only a small component of the 'CLASS' curriculum." "A thorough treatment of wetlands." "Material is specific to California."

272

273

THE EARTH'S SPONGE

6

UNIT V - Lesson 6 Teacher Instructions

OVERVIEW

Students study watershed and map drainage patterns of their school grounds.

FOCUS

Students will:
- observe a demonstration on how soil in a watershed acts as a sponge, filtering and purifying water;
- predict and map rainwater drainage patterns of their school and home, then compare their prediction to the actual drainage patterns;
- determine the drainage in their community's watershed; and
- compare the school ground watershed to the community watershed.

AT A GLANCE

ADVANCE PREPARATION:
- Follow preparation directions in Setting the Stage 1a and 1b.
- Prepare a map of the school grounds. Use the one from the previous lesson, "Who Planted the Maple on Elm Street," if available. Make copies for all students.
- Obtain a topographical map of your area (see Digging Deeper) and make a transparency of one section.

DURATION: 3 class periods

GROUPINGS: whole class and small groups

MATERIALS: flower pot, cotton ball, aquarium type charcoal, soil, dirty water, 1/2 gallon (2 liters) milk carton, clear cup or glass, measuring cup, dish pan, 4" x 8" (10 cm x 20 cm) sponge, school map, pencils, a transparency of a section from a topographic map of your area, and the following:

TRANSPARENCY:

A - A Small Rural Watershed

CROSS CURRICULUM CONNECTION: art, geography, mathematics

PROCESS SKILLS: observing, communicating, comparing, organizing, relating, inferring

VOCABULARY

aquifer, erosion, filter, groundwater, percolation, runoff, subsoil, watershed, water table

BACKGROUND INFORMATION

Definition of a Watershed

A watershed is the entire area which contributes water to a drainage system or stream. It supplies us with water by holding rainwater in groundwater aquifers and channeling it into rivers and streams. Watersheds can be very small (e.g., an acre of land which drains into a pond). They can also be as large as the Mississippi River watershed, which covers over 1,234,000 square miles (3,208,400 square kilometers) and includes many rivers.

Functions of a Watershed

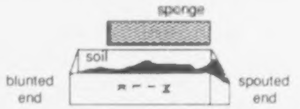
Picture a watershed as the earth's sponge, filtering as well as absorbing and storing water. As water percolates through the soil in the watershed and into the water table, the soil filters some of the impurities. A functioning watershed must allow water to soak into the ground. Forest soils have a great capacity for holding water and, therefore, serve as natural regulators of water flow.

Consequences of a Damaged Watershed

Uncontrolled logging or fire can strip land of its cover, decreasing its water holding capacity. If the majority of the land in a watershed is paved or not covered with vegetation, it cannot absorb the excess rainfall and water will run off rapidly. This results in floods and erosion, and decreases the available groundwater supply during the dry months of the year. Floods destroy farms, houses, and other property. Eroded soil chokes waterways, reducing the amount of water the stream or lake can contain. This creates problems for fish as well as people.

SETTING THE STAGE

1. Discuss the definition of watershed with the class (see Background Information). Perform the following activities:
   a. Demonstrate how a watershed functions as the earth's sponge by conducting the following two experiments:
      - Lay a milk carton horizontally on the table with the spout pointing upward. Carefully cut and remove the top side, including the spout. Fill the carton half full of soil. Place a dishpan under the carton to catch the runoff. Tilt the carton at a 45° angle towards the spout end. Ask students to predict what would happen when a cup of water is poured on the soil. Pour the water on the soil at the blunt end of the carton (opposite the spout), and observe the eroded soil wash away into the dish pan.
      - Add more soil, if necessary, to fill the carton half full. Place a 4" x 8" sponge on top of the soil. Press the sponge down firmly. Ask students to predict what would happen when you pour the cup of water on the sponge. As you tilt the carton and pour the water, observe the sponge absorbing most of the water, minimizing the runoff.



   b. The concept of how a watershed filters the water can be illustrated using dirty water and a flower pot. Block the hole in the bottom of the flower pot with a ball of cotton, which takes the place of subsoil. Place a one inch layer of charcoal on the bottom and add soil. Place a clear cup or glass under the pot. Slowly pour 1 cup of dirty water into the pot. The water running out the bottom of the pot should be relatively clean.

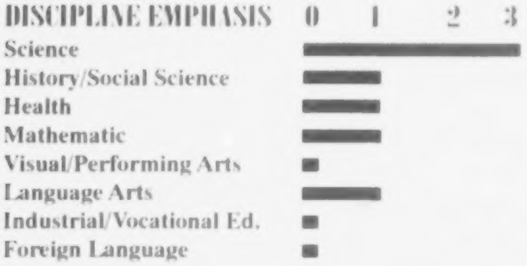
2. Show the transparency and review the definition of a watershed. Discuss the role and importance of a watershed (see Background Information).

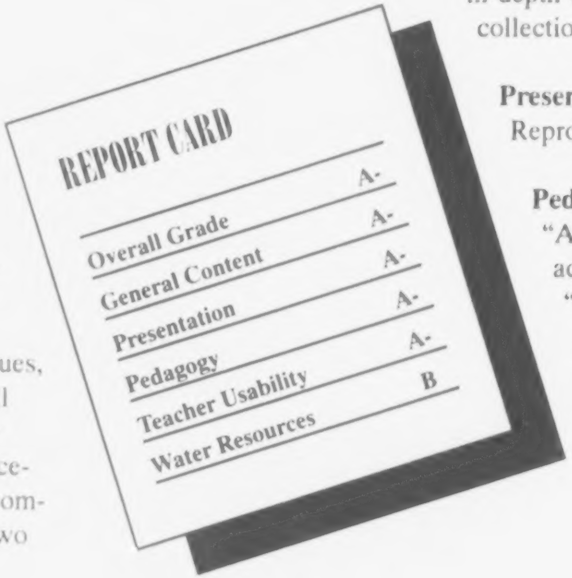
Environmental Science Activities Kit

The Center for Applied Research
in Education
Prentice Hall
Order Processing Department
P.O. Box 11071
Des Moines, Iowa 50380-1071
(800) 288-4745

$29.95. 1993. 332 pages.

This resource book offers lesson plans, laboratory activities, and worksheets suitable for reproduction. Thirty-two activities are arranged in six units: Land Use Issues, Wildlife Issues, Water Issues, Atmospheric Issues, Energy Issues, and Human Issues. All activities are accompanied by teacher background information, specific procedures, reproducible materials, and recommended extensions. Three of thirty-two activities deal directly with water.





REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	A-
Pedagogy	A-
Teacher Usability	A-
Water Resources	B

COMMENTS

General Content
"Presentation and background information are complete." "Three in-depth water activities are presented." "A good supplemental collection of environmental activities."

Presentation
Reproducible student worksheets.

Pedagogy
"An appropriate level of detail - challenging, hands-on activities." "Connections are made to the students' lives." "Built on a solid environmental education foundation."

Teacher Usability
"Offers a comprehensive guide to environmental issues and activities." "Superb appendices."

Specific Content on Water Resources
"Great overall book, although the emphasis is not on water."

Vocabulary

chlorination
effluent
potable
primary treatment
secondary treatment
septic tank
settling tank
sewage
sludge
tertiary treatment

Teacher Preparation

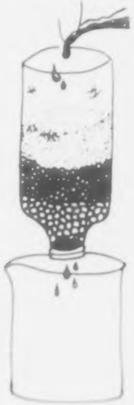
1. Photocopy the Background Information sheet (11.1), Instructions and Data sheet (11.2), and Questions sheet (11.3).
2. Obtain and prepare the materials listed here.
3. Make a sample filter to show to the students.
4. Consider having the students bring in the 2L bottles and having them cut out the bottoms.

SAFETY CONSIDERATION

Remind the students to wash their hands after completing this activity.

Procedure

1. Show the students two samples of water: one that is clear (sample A) and one that is muddy (sample B). Ask which one is safe to drink. Most will probably say that the clear one is safe to drink (potable). Then ask whether all pollutants can be seen.
2. Point out that water purification involves the removal of both visible and invisible pollutants.
3. Ask how visible pollutants might be removed from a water sample.
4. Distribute the Background Information sheet (11.1) and the Information and Data sheet (11.2).
5. Show a sample of a filter system and how to use it.
6. Have the students do the activity and clean up.
7. Discuss the activity (see the discussion questions below).
8. Distribute the Questions sheet (11.3) and discuss the questions.



Discussion

1. Which filtration system worked best? Why?
2. Did the filters remove all of the pollutants?
3. What other processes are used in primary sewage treatment? in secondary? in tertiary?

---

4. What are some of the sources or causes of water pollution?
5. What are some pollutants that cannot be seen in water?
6. What could be done to improve the filters?
7. What else is done in primary treatment?
8. Primary, secondary, and tertiary treatment all generate sludge or waste. What could be done with it?
9. The Law of Conservation of Matter (Mass) tells us that matter can neither be created nor destroyed. How does this relate to sewage-treatment plants?
10. Industrial processes produce many water pollutants. What are some of the options for paying to remove them from the water?
11. What is the relationship between population and the need for water-treatment plants?
12. How is water purified in nature? Is the water in a mountain stream really pure water? Are naturally occurring impurities such as algae, silt, and dissolved minerals any more or less of a concern than are toxic chemicals?

Answers to 11.3, Water Treatment: Questions

1. Primary sewage treatment involves removing the large particles by a series of screens, then allowing the solids to settle out, possibly with a filter system. The water is chlorinated before release. Secondary treatment adds bacterial and microorganisms that remove much of the organic matter. Tertiary treatment involves a variety of chemical reactions to remove various additional pollutants.
2. The Law of Conservation of Matter or Mass says that matter can neither be created nor destroyed. Pollutants, whether in the water, in the air, or on land, will not just "go away." The atoms and molecules will still be around. We need to find ways to reduce the production of harmful molecules and to alter, remove, or store those that are produced.
3. In the home, one can reduce the amount of chemicals such as cleaners, pesticides, fertilizers, paints, and so forth, that are added to the water system by not buying them in the first place, by minimizing their use, and by disposing of containers properly. If on a septic tank system, the homeowner should be sure that it is functioning properly. Voters need to be willing to vote for (and pay for) good sewage treatment facilities and water pollution control laws (and officials who will enact and enforce them).
4. Industries produce what we purchase. By becoming informed about products, we can make intelligent choices in our purchases. We also need to be willing to pay for increased production costs caused by pollution control at the manufacturing site. As voters, we need to be willing to support pollution-control laws and to insist that our governmental agencies enforce them. We also need to support (and participate in?) the development of ways of living that pollute less.

Extensions (See Activity 32 for suggestions for student projects.)

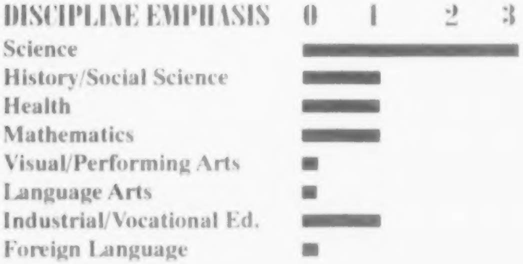
1. Have the students devise methods to further purify the water. Include granulated activated charcoal.

Groundwater Study Guide

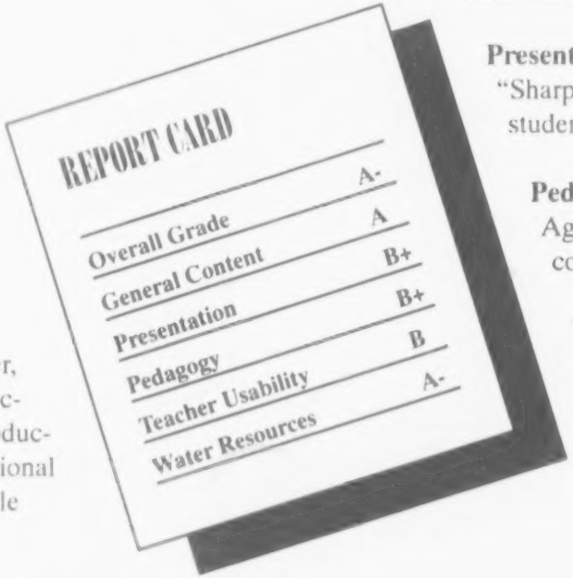
Wisconsin Department of Natural Resources
Wisconsin Agency Document Sales
Box 7840
202 South Thornton Avenue
Madison, Wisconsin 53707
(608) 266-3358

$10.00. 1990. 35 pages.

"The Groundwater Study Guide" offers an overview of groundwater and suggested classroom activities including the construction of a groundwater model. Activities are organized in four sections: The Water Cycle, The Movement of Groundwater, Household Water, and Resource Protection. Other components include reproducible student worksheets, a list of additional resources, a glossary and a Water Cycle poster.



🌧 🌧 🌧 🌧



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	B+
Pedagogy	B+
Teacher Usability	B
Water Resources	A-

COMMENTS

General Content
"A comprehensive study of groundwater and how it becomes contaminated."

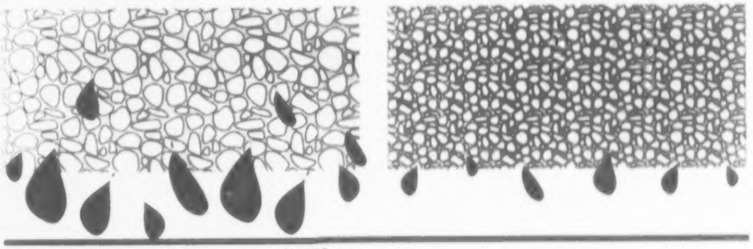
Presentation
"Sharp professional illustrations with separate sections for student worksheets."

Pedagogy
Age-level appropriate activities. "Makes some real-life connections."

Teacher Usability
"A time frame for each activity would be helpful." "Offers thorough appendices and resources section." "'More Groundwater Activities' allows the educator to dig deeper."

Specific Content on Water Resources
"Excellent coverage of groundwater concepts and issues including contaminant plumes, strata/ aquifer geology, and environmental economics." "Some of the material is specific to Wisconsin."

How Groundwater Moves



Porosity and Permeability

Goals: To help students understand how characteristics of soil particles (e.g., size and shape) affect the porosity and permeability of soil and thus, groundwater storage and movement.

Subjects: Science, Math

DPI Objectives: SC: A1-A3

Grades: 6-9

Materials:

- ❖ Porosity and Permeability activity sheet
- ❖ gravel*
- ❖ sand*
- ❖ clay*
- ❖ potting soil*
- ❖ containers for used clay, soil, sand and gravel

For each group of 2-3 students:

- ❖ 4 test tubes
- ❖ test tube rack
- ❖ 100 ml glass beaker
- ❖ small funnel
- ❖ 100 ml graduated cylinder
- ❖ 4 sheets of round filter paper
- ❖ glass marking crayon

* These materials must be very dry. Spread soil materials on a cookie sheet and dry in oven at 250-275° F. Break up clay and potting soil after drying so that no clumps remain.

Background: *Just how solid is "solid ground?"* The material beneath our feet is rarely solid. Soil is made up of particles of rock and the spaces between these particles. The amount of space between soil particles is called porosity. You can estimate the porosity of a soil by measuring the amount of water it can hold.

Underground, water percolates down through soil and flows from higher elevations (such as a hill) to lower elevations. The ease with which water moves through a soil or rock type is called *permeability*. You can estimate the permeability of soil by timing how quickly water can flow through it.

Physical characteristics of soil particles, such as size and shape, influence the porosity and permeability of soils and rocks. Coarse materials, like gravel and sand, tend to be both porous (they have large pore spaces that can fill with water) and permeable (water passes easily between the large particles). Some fine materials, such as clay, may hold a lot of water yet transmit very little because water cannot move easily through the tiny pore spaces.

An *aquifer* is a rock or soil formation that can both store and transmit a significant amount of water. A well drilled in a sand aquifer is likely to yield a lot of water; a well drilled in clay will probably yield little.

Procedure:

A) Predicting porosity and permeability

1. Examine the gravel, sand, soil and clay. Predict which materials can hold the most water and which ones water will flow through fastest. Record your predictions on the chalkboard. Then, in small groups, either investigate each material or assign groups to one soil material and compile class results on the chalkboard.

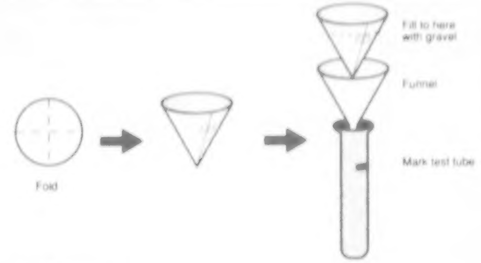
B) Measuring porosity

1. With a marking crayon, place a line about 1/2 way up the side of a small beaker. Fill the beaker with water to the line. Pour this water into a 100 ml graduated cylinder. Record this volume on your data sheet under "total volume." Dry the beaker.

2. Fill the beaker with gravel to the line and fill the graduated cylinder to the 100 ml mark with water. Pour water from the graduated cylinder into the beaker until it reaches the line. Record the volume of water needed to saturate (fill the pores of) the gravel on your data sheet under "pore space." Divide this volume by the "total volume" and multiply by 100 to get percent pore space in your sample of gravel. Record this value under "porosity" (% pore space). Repeat the investigation with samples of sand, soil and clay. (Note: For potting soil and clay, make sure that the water has time to soak in completely.) Record your results.

C) Measuring permeability.

With a marking crayon, place a line about 1/2 way up a test tube. Put the test tube in the rack and put the stem of a small funnel inside the test tube. Fold a circular filter paper into quarters, open it into a cone, and insert it into the funnel. Fill the cone with gravel to about 1/2" from the top. Pour water from a beaker into the filter. Using a clock, a watch or by counting, time how long it takes to fill the test tube to the line. Record the results on your data sheet under "permeability." Return the sample of gravel to the used gravel container and discard the filter paper. Repeat the experiment with sand, soil and clay.



Make bar graphs of your results and complete questions on the "Porosity and Permeability" activity sheet. Discuss your results and answers:

- ❖ Did your results match your predictions?
- ❖ Which material is the most permeable? Why?
- ❖ Which is the least permeable? Why?
- ❖ Which soil is the most porous? Why?
- ❖ Which is the least porous? Why?
- ❖ If you drilled a well in these materials, which one do you think would yield the most water?

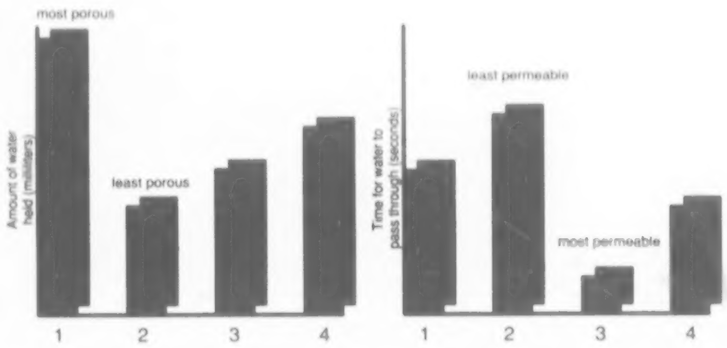
Going Beyond:

1. Invite a certified soil tester or county on-site waste disposal (septic system) specialist to discuss how porosity and permeability of soil and rock are measured in the laboratory and in the field.

2. Compare the porosity of a variety of rocks. Record the weights of small pieces of limestone, sandstone, shale, granite, obsidian, lava, etc. Soak the rocks in water for several days. Remove them from the water and pat them dry. Weigh the rock pieces again and record your results. Compare the mass of each rock before and after soaking. Discuss your results in terms of the rock's ability to hold water. Note: water may move through cracks in rock as well as through the pore spaces. The amount of cracking in a rock determines its "secondary porosity."

3. Investigate the effect of organic material on a soil's permeability and its ability to filter contaminants. Prepare four "contaminated" water samples containing 1) vegetable oil, 2) vinegar, 3) detergent and 4) green food coloring. Pour small amounts of each sample through 1) sand, 2) sand + potting soil, 3) clay, 4) clay + potting soil. Compare filtering times of the different soils. Compare appearance of contaminant samples before and after filtering (use pH paper for vinegar). Filter plain tap water as a control.

Adapted from ***Groundwater: A Vital Resource****, Cedar Creek Learning Center and the Tennessee Valley Authority.*

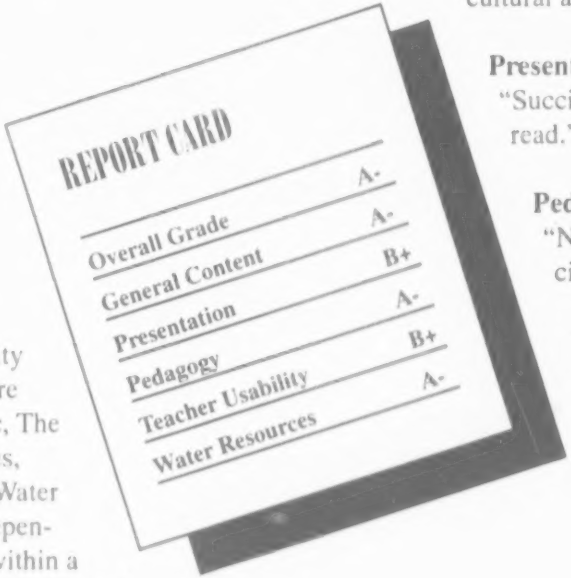


A Sense of Water

Southern Arizona Water Resources
Association
48 North Tucson Boulevard, #106
Tucson, Arizona 85716
(520) 881-3939

Publication is no longer available for purchase. Permission is granted for teachers to reproduce the material for education use only. 1984. 150 pages.

"A Sense of Water" provides a broad range of water-related activities with particular emphasis on water availability in the arid Southwest. The activities are organized in six sections: Water Magic, The Wonders of Water, Less Water Climates, Water Working, Water Warnings, and Water Wisdom. Activities can be taught independently of one another or sequentially within a water unit. Glossary, topic and subject index, and conceptual framework are offered.



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	B+
Water Resources	A-

COMMENTS

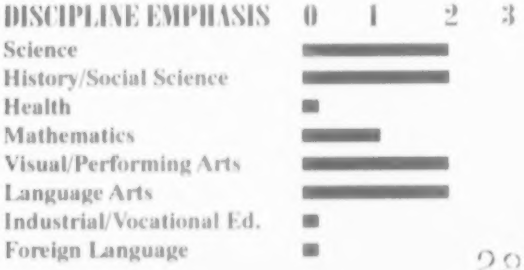
General Content
"Impressively thorough for how compact this is!" "Addresses cultural and historic water uses in arid areas - pros and cons."

Presentation
"Succinct and well organized." "Small print may be difficult to read."

Pedagogy
"Needs more hands-on activities." "Thematic and interdisciplinary." "A strong Native American approach."

Teacher Usability
"Very good background information, glossary, and index." "It would be helpful to have student materials as well as the Teacher's Guide."

Specific Content on Water Resources
Regional treatment of water issues relevant to arid environments.



155

Wildlife Rations

objective

Students will be able to:
- Calculate the amount of water different types of wildlife use
- Describe that water is essential to all animals and their behavior is often affected by their water sources.

materials

Make copies of word problems.

Gina Biamonte

background

Desert animals have adapted to survival in this sometimes harsh environment. All have different water needs but depend on water for survival.

In the Sonoran desert during the summer, desert bighorn sheep can travel long distances from water and even go a week between drinks. The ewes and lambs stay closer to a permanent water source. Burros, an exotic wildlife species, often compete for limited water resources with native wildlife resources.

Water availability influences the migration patterns of animals. Animals have varying capacities to go without it. The less able they are to survive without it, the closer they must live to a permanent source of water.

Competition for the scarce water in the desert often means animals will travel many miles to drink from a waterhole. The following conversions are needed for this activity:

1 gallon = 4 quarts
1 gallon = 8 pints
1 gallon = 3.7854 liters
1 liter = .26417 gallons
1 gallon of water = 8 lbs.

introduction

Explain the water needs of several desert creatures drawing from information in the background. Talk about competition for water among the animals and how different kinds of animals often depend on the same water source.

The activity is to set up a hypothetical situation with real facts about animal water needs and determine how much water would be needed at a waterhole to support a given wildlife population.

Chapter Reference

Water Magic

Grades

7-8

Subject

Math, Science

Length of Activity

one classroom session

Concept

All living things are dependent on water to maintain life. (A)
There is great variation in water needs of living animals. (C)
Animal and plant behavior is related to the availability of water. (E)

Key Vocabulary

availability, migration, waterhole

Credits

Adapted from "Drinking Water," "Burros Drink Water Too!" and "Desert Tortoise" in Teachers Resource Guide for Environmental Education, Arizona State Department of Education, 1977. Used by permission.

notes

Answers to Word Problems

BIGHORN SHEEP (1)

Given: 60 miles
4 gallons

$\frac{60\ mi}{4\ gal} = 15\ mi/gal$

*A Bighorn sheep can get 15 miles per gallon.

1 gal/day × 7 days/wk = 7 gal/wk
2 pints/day × 7 days/wk = 14 pints/wk = 1¾ gal/wk

7 + 1¾ = 8¾

*A ewe and her lamb drink 8¾ gallons of water in a week.

BURRO (2)

Given: 12.2 liters
5 minutes

$\frac{12.2}{5} \approx 2.44$

*The burro drinks 2.44 liters in a minute.

(12.2)(.26 gal) = 3.17 gal

*12.2 liters is 3.17 gallons.

$\frac{144\ hrs}{36\ hrs} = 4$

Each burro will drink 12.2 liters in a 36-hour period. There are four 36-hour periods and five burros, so:

(12.2)(4)(5) = 244

*Five burros drink 244 l in 144 hrs.

144 hrs = 6 days

$\frac{244\ l/day}{6\ days} = 40.44\ l/day$

7(40.44) = 283.08

*Five burros would drink 283.08 liters in a week.

TORTOISE (3)

40% of 8 pounds = .4(8 lbs) = 3.2 lbs

*A tortoise can drink up to 3.2 lbs of water.

3.2 lbs ÷ 8 lbs/gal = .4 gallons

*3.2 lbs of water is .4 gallons.

$\frac{12\ lbs/wk}{8\ lbs/gal} = 1.5\ gal/wk$

*A tortoise would need 1.5 gallons in one week.

activity

- Start activity by discussing the importance of water to living organisms. Have the students try to think of any animal that does not need water either directly or indirectly. Concentrate on animals around Arizona.
- Provide the information needed for word problems on chalkboard or on a handout.
- Let students calculate the answers to the various questions.

Word Problems

1

The male Bighorn sheep can easily go a week without water during the summer months. He may travel 60 miles between drinks. If he drinks four gallons when he does come to water, how many miles does he get to the gallon of water? If the ewes and lambs come to water daily and the ewe drinks 1 gallon and her lamb drinks 2 pints, how much water do a ewe and her lamb drink per week?

2

At the same waterhole, a wild burro that had not drunk for 36 hours consumed 12.2 liters of water in 5 minutes. How much did he drink in 1 minute? How many gallons in 12.2 liters? How much would five burros drink in 144 hours? In a week?

3

A desert tortoise can drink up to 40% of his weight in water. If a tortoise weighs 8 pounds, how many pounds of water can he drink? How many gallons is that? If a tortoise drinks 12 pounds a week, how many gallons do they need?

4

How much water must be available in the waterhole for 5 rams, 10 ewes, 7 lambs, 10 burros and 3 tortoise, during the months of June, July and August?

Waterhole Supply (4)

From previous answers the following is known:
A ram drinks 4 gal/wk
A ewe drinks 7 gal/wk
A lamb drinks 1.75 gal/wk
A tortoise needs 1.5 gal/wk
Five burros drink 40.44 l/day

(40.44 l)(.26417 gal/l) = 10 gal

$\frac{10\ gal/day}{5\ burros} = 2\ gal/day/burro$

2 gal × 7 = 14 gal

So one burro needs 14 gallons of water each week.

June, July & August have 13 weeks.

The water hole supply requirement can now be calculated:

(5 rams)(4 gal/wk/ram)(13 wks) = 260 gal
(10 ewes)(7 gal/wk/ewe)(13 wks) = 910 gal
(7 lambs)(1.75 gal/wk/lamb)(13 wks) = 159.25 gal
(3 tort)(1.5 gal/wk/tort)(13 wks) = 58.5 gal
(10 burros)(14 gal/wk/burro)(13 wks) = 1820 gal

260.00 gal
910.00 gal
159.25 gal
58.50 gal
+1820.00 gal
3207.75 gal

*The waterhole must have at least 3208 gallons of water available during June, July & August.

closure

Discuss the ways animals have adapted to desert conditions. What are the similarities and differences? How might the animals talked about get water if their usual waterholes dried up?

Check answers to the questions with the class and talk about how man provides for the water needs of animals.

The Game & Fish State Agency is directly responsible and can bring interesting and accurate information to this discussion either by class visit or by telephone call.

evaluation

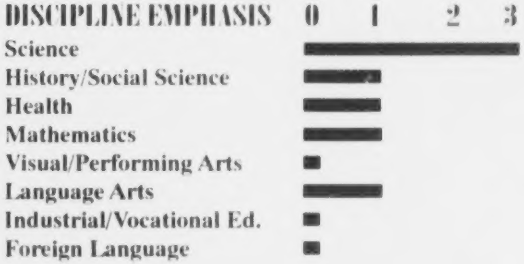
Have the students hand in the answers to the word problems in this activity. The evaluation can be in two parts:
1. Formulation of problem
2. Correct computation

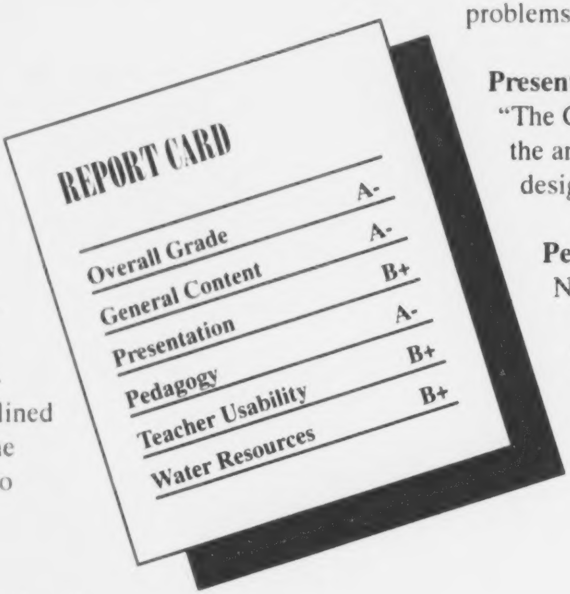
Ground Water Education

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

$20.00. 1995. Package format.

"Ground Water Education" offers lesson plans and materials that focus on groundwater, aquifers, and groundwater pollution. Laboratory sessions and classroom activities, together with reproducible worksheets, overhead masters, background information, role-playing scenario, resources, and glossary are outlined in the Teacher's Guide (55 pages). The California Ground Water poster is also included.





REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	B+
Water Resources	B+

COMMENTS

General Content
A comprehensive groundwater curriculum for California. "Details problems associated with California agriculture and groundwater."

Presentation
"The Ground Water map is excellent." "The cover design masks the answers when pages are reproduced - a great paper-saving design." "Attractive and well designed."

Pedagogy
Needs more student investigation.

Teacher Usability
"The groundwater model would be excellent. Students could watch groundwater move through different materials." "Teachers would need some geology background to teach with this material."

Specific Content on Water Resourceses
Groundwater is covered thoroughly, but seems to de-emphasize water quality in favor of geology.

Note: In this compendium, the term "groundwater" has been spelled as one word. The term is spelled as two words in specific "Ground Water Education" materials.

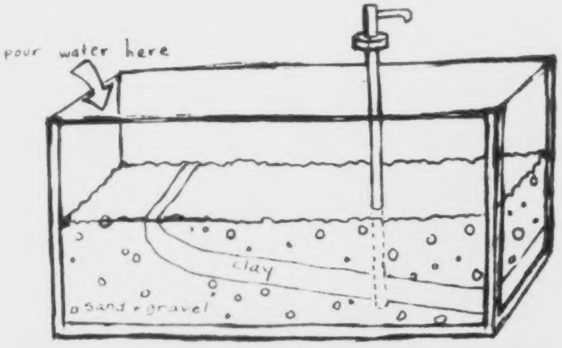
Lab The Aquifer

Introduction

Ground water is stored in layers of sand, gravel and rocks below the surface of the earth. If these layers contain water they are called aquifers. As users, people need to understand how water is stored and the effects of over using this valuable natural resource.

This lesson will explain how water is stored in sand, gravel and rock, and demonstrate different types of aquifer systems (confined and unconfined). A layer of rock or clay that does not let water through is called a confining layer, or aquitard. This layer can stop water from seeping into deeper sand or gravel. The aquifer above the confining layer is called the unconfined aquifer. The layer below the confining layer is called the confined aquifer.

Be sure to review the hydrologic cycle before beginning this exercise.



Answers to questions

Note to teacher: Use the flaps on the front and back covers of this book to mask off these answers when photocopying the exercise for your students.

Q1. The levels will probably not be at the same height because the confining layer prohibits water from going to the bottom of the model. The aquifer fills from the bottom up.

Q2. The hole represents a pond, lake or wetland and is partially filled with water because the bottom is below the water table.

Objectives

The students will:

1. Identify an aquifer as a layer of sand, gravel or rock that stores water underground.
2. Define porosity as the spaces between the particles of sand and gravel, as well as cracks and other spaces in rocks in which water is stored.
3. Distinguish between ground water stored in a confined and in an unconfined aquifer.
4. State how stored water in the aquifer can be used by people.

Materials (for each group)

- Plexiglas box similar in size to a small ant farm or terrarium
- sand and gravel mixture
- 100 ml graduated cylinder
- modeling clay
- clear soda straw or clear Plexiglas tubing
- pump nozzle, like one from a liquid hand-soap bottle
- water
- spoon
- 500 ml blue colored water (use blue food coloring)
- 500 ml yellow colored water (use yellow food coloring)
- markers (grease pencil)

Student Directions

1. *Set up the plastic ground water model as shown in the drawing. Make sure that the confining layer (modeling clay) seals tightly around the clear straw or tube, and along the edges of the plastic box.*
2. *Pour 30 ml of water onto the confined aquifer side of the model. Mark level with grease pencil.*
3. *Pour 30 ml of water onto the unconfined aquifer side of the model. Mark level with grease pencil.*

Q1 Are the marks at the same height on the model? Why or why not? Does the aquifer fill from the top to the bottom or from the bottom up?

4. *Continue to add water to both sides of the model until the level on both sides is approximately ¾ of the way up to the top. Mark both sides with the grease pencil. This level marks the top of the saturated zone and is called the water table.*
5. *Dig a hole with the spoon to a level below the water table.*

Q2 What have you created in the aquifer?

Q3 How can you raise the water table?

6. *Add blue colored water to the confined aquifer until the water table is almost to the top of the surface of the sand and gravel mixture.*

Q4 Does this change the water table in the unconfined aquifer? Why or why not?

7. *Insert the pump nozzle into the straw or tube and use it to remove some of the water from the confined aquifer.*

Q5 Does this change the water table in the unconfined aquifer? Why or why not? What real object is the pump and tube a model for?

8. *Add the yellow colored water to the unconfined aquifer until the two water tables are equal.*

Q6 If the yellow color represents a toxic substance, how do you know whether it has contaminated the unconfined aquifer?

Conclusion

Write a paragraph that explains the following terms: aquifer, confining layer, unconfined aquifer, confined aquifer, water table and well.

Answers

Q3. You can raise the water table by adding more water.

Q4. When you add water to the confined aquifer, it does not change the water table level of the unconfined aquifer because the confining layer stops water from moving between the two aquifers.

Q5. When you draw water out of the confined aquifer, it does not change the water table level of the unconfined aquifer because the confining layer stops water from moving between the two aquifers. The pump represents a well.

Q6. If the toxic substance (yellow) has gotten into the confined aquifer, it will mix with the blue color to produce green. If the model was constructed correctly, this should not happen. Water between the two aquifers does not mix.

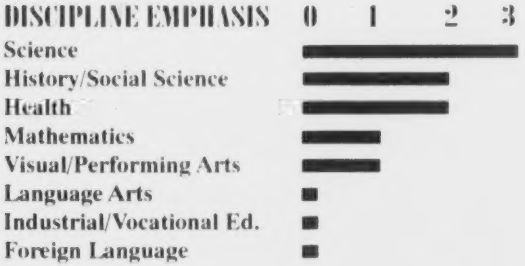
Adapted from U.S. Geological Survey's *Groundwater Notebook*.

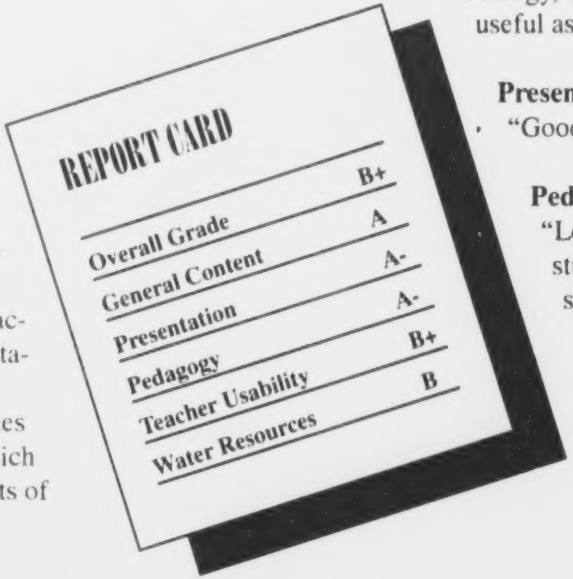
Acid Rain

Great Explorations in Math and Science
(GEMS)
Lawrence Hall of Science
University of California at Berkeley
Berkeley, California 94720-5200
(510) 642-7771

$15.00. 1994. 176 pages.

"Acid Rain" is one in a series of GEMS guides, a guided-discovery based curriculum project of Lawrence Hall of Science. Eight sessions introduce students to pH, acidity, the interaction of airborne pollutants and precipitation, and the effects of acid rain on aquatic ecosystems. The unit concludes with a town meeting simulation in which four interest groups present their points of view regarding an acid rain problem





REPORT CARD

Overall Grade	B+
General Content	A
Presentation	A-
Pedagogy	A-
Teacher Usability	B+
Water Resources	B

COMMENTS

General Content
"A comprehensive and contemporary study of acid rain." "Integrates ecology, chemistry, and meteorology with other disciplines." Very useful as a supplementary piece on acid rain.

Presentation
"Good illustrations and 'visual reminders'."

Pedagogy
"Lots of lab-based activities, simulations, and projects for students." "A strong element of constructivism." "Offers a strong literature strand."

Teacher Usability
"Labor intensive" in terms of some preparation work. Teacher background is excellent.
"A teacher needs very little science background to teach this."

Specific Content on Water Resources
"Provides a thorough depiction of acid rain."

What You Need

For the class:

- ☐ the table of class results for the "fake lakes" experiment, as recorded on butcher paper in Session 4
- ☐ the set of demonstration "fake lakes" with the Tums® tablet added, and the set of control "fake lakes," as set up in Session 4
- ☐ the description of an imaginary town entitled "Welcome to Laketown!" (page 83)
- ☐ 1 copy of each of the 4 group descriptions, for the student groups representing politicians, manufacturers, townspeople, and fisherpeople (masters included, pages 84–85.)

For each group of 4 students:

- ☐ access to the seed germination experiments set up in Session 1
- ☐ a wooden popsicle stick or toothpick, to assist the students in examining the germination trials

For each student:

- ☐ 1 copy of the article, "Efforts Continue Against Acid Rain" (master included, page 86)

EFFORTS
CONTINUE AGAINST
ACID RAIN

Getting Ready

Before the Day of the Activity

Duplicate:

- 1 copy of each of the four group descriptions—one for each of the groups
- 1 copy of the article, "Efforts Continue Against Acid Rain" for each student

On the Day of the Activity

1. If they are not already posted, put up the results of the "fake lakes" experiments (obtained in Session 4 and recorded on butcher paper) on the classroom wall, in a convenient location, so all students can see them.

2. Set out the demonstration set of "fake lakes" of each soil type that you treated with Tums tablets in Session 4, along with the control set of lakes of each soil type subjected to acid rain, but without any Tums treatment.

3. Have available for examination the seed germination trials that the class set up in Session 1.

Reviewing the "Fake Lakes" and Buffer Results

1. Refer the class to the posted table of experimental results from Session 4. Ask the students, "What do you think were the most important results of the experiment?" If responses do not include the following, ask: "What happened to the pH of each of the lake types after normal rain?" "What happened to the pH in each case after the acid rainstorm?"

2. Ask the class to recall what range of pH will safely support aquatic life. [pH 5–9] Ask if any of their lakes were still able to support life after the acid rainstorm. If some were, ask them what might account for this. [Some soil substrates have natural buffers or bases that can neutralize or partially offset the effects of acid solution flowing through them.]

3. Explain that what the class observed in their model lakes (that some lakes were less acidic than others after an acid rain, depending on the reaction of the substrate to the acid) is what scientists call a lake's ***buffering capacity***. Each type of lake substrate has a certain buffering capacity, or ability to make the lake less acidic. Some lakes can neutralize a lot of acid before becoming acidic themselves, while other lakes have little or no buffering capacity.

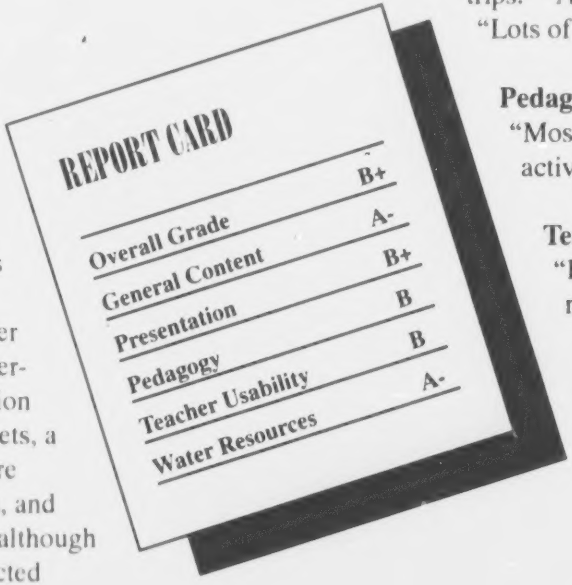
BEST COPY AVAILABLE

Water Activities Manual

Santa Barbara County Water Agency
Water Education Program
123 East Anapamu Street
Santa Barbara, California 93101
(805) 568-3546

No charge. 1995. 114 pages.

Designed for Santa Barbara County, the "Water Activities Manual" provides teacher background information and activities arranged in six sections: The Wonders of Water, Water and Geology, Local Water Sources, Water Treatment, Water Problems and Issues, and Water Conservation. Science experiments, simulation activities, tests, reproducible worksheets, a bibliography, and a list of resources are provided. Suggested field trips, maps, and figures are specific to Santa Barbara, although the classroom activities can be conducted anywhere.



REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	B
Teacher Usability	B
Water Resources	A-

COMMENTS

General Content

"Includes many supporting labs, activities, and suggestions for field trips." "A good resource for Santa Barbara County water issues." "Lots of information in extensive reading units."

Pedagogy

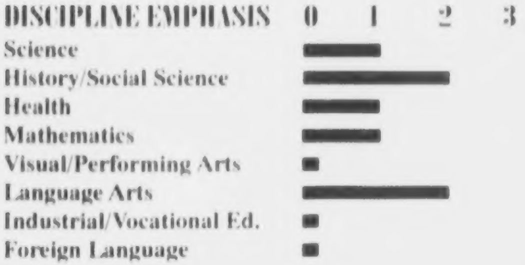
"Most activities are based on readings and question-answer activities."

Teacher Usability

"Provides good breadth of information, but the activities need to be more challenging."

Specific Content on Water Resources

"Contains information on California water problems, some specific to Santa Barbara County."



EXPERIMENT #12 – SEDIMENTATION RATES

Activity: Demonstration of soil settling in water.

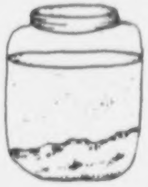
Objective: Following experimentation, students will be able to measure and predict the settling rates of different sediment types.

Approximate Length of Unit: 30 to 45 minutes

Materials:

- 3 types of soil (coarse, medium, and fine-grained)
- Stop watch
- Water
- Large jars with lids

Procedure:



1. Fill 1 jar with water.
2. Take 1 particle of each type of soil and drop, one at a time, into the filled jar.
3. Time how long it takes each particle to reach the bottom.
4. Now pour out some of the water and fill the jar about 1/2 way with a blend of the three soil types.
5. Shake the jar up and watch how the soil settles.
6. Record data and observations.

Questions:

1. Which type of soil settles slowest?
2. What happened to the mixed soil?
3. In a river which type of sediment would be deposited first? Last?

Answers to Questions:

1. The biggest particles will settle fastest. The smallest particles will settle slowest.
2. The mixed soil should settle in layers with big particles on the bottom and small particles on top.
3. Large rocks would be deposited first in a river. Small particles are the last deposited.

EXPERIMENT #13 – HOW MUCH CAN WATER CARRY?

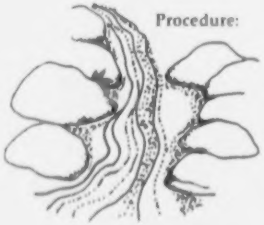
Activity: Experiment exploring the amount of sediment water can transport.

Objective: Following experimentation, students will be able to predict which type of water will carry more sediment.

Approximate Length of Unit: 30 to 45 minutes

Materials:

- 2 liters of water from a stream
- Funnel
- 2 paper towels
- 2 liters of water from a stream **after a heavy rain**



Procedure:

1. Place the paper towel in the funnel so the water has to flow through it.
2. Shake up water to mix in sediment and pour through funnel, collecting sediments on the paper towel.
3. Remove paper towel and measure the amount of material.
4. Repeat process with second jar.
5. Record data, noting the color of the water.

Questions:

1. Which water had more materials in it?
2. Why did one water have more material in it?
3. What could affect the amount of material water carries?
4. What types of material was the water carrying?

Answers to Questions:

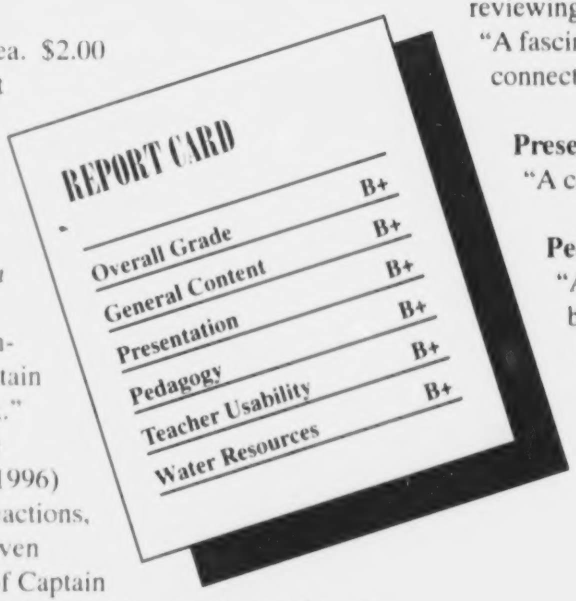
1. The storm runoff should have more material in it.
2. Storm runoff should have more material in it because material will have been eroded and added to it. Also, the water is moving faster and therefore has more force to move things.
3. Answers will vary and should include ground cover, rain intensity, slope of ground and vegetation.
4. Answers will vary.

The Further Adventures of Captain Hydro

Public Information Office
East Bay Municipal Utility District
P.O. Box 24055
Oakland, California 94623-1055
(510) 287-0138

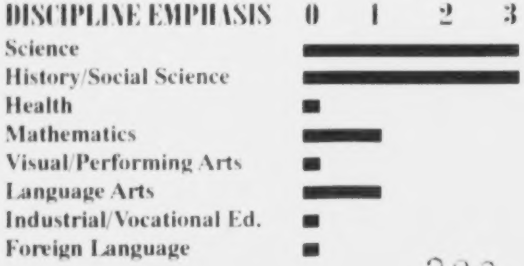
No charge within EBMUD service area. $2.00 per teacher guide and $.50 per student workbook outside EBMUD service area (quantity discounts are available). Booklets.

"The Further Adventures of Captain Hydro" features the character *Captain Hydro* in a student comic book (15 pages, 1977) that reinforces water concepts introduced in "The Official Captain Hydro Water Conservation Workbook." Two teacher's guides complement the program. "Water Magic" (49 pages, 1996) focuses on the scientific properties, reactions, and interactions involving water in seven activities. "The Further Adventures of Captain Hydro Teacher's Guide" (25 pages, 1987) presents water issues from an historical perspective, using ancient civilizations as the backdrop.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B+
Teacher Usability	B+
Water Resources	B+



COMMENTS

General Content

Material creatively weaves science with ancient history. "I enjoyed reviewing this!"

"A fascinating look at history, science, and water... This truly connects water to human history."

Presentation

"A comic book format."

Pedagogy

"A good balance of fun LEP-conscious graphics and background." "Labs on the physical and chemical properties of water are adequate although simple." "Needs authentic assessment strategies."

Teacher Usability

"This provides an unusual and interesting supplemental curriculum." The materials should be treated as separate components since each serves a different purpose.

Specific Content on Water Resources

Analyzes water use in ancient civilizations.

UNIT FOUR: Ancient Egypt

OBJECTIVES:
- **To understand how vital the Nile River was to the formation of the ancient Egyptian culture.**
- **To show that if a water source is managed properly it can serve people for a very long time.**

BACKGROUND

Point out the location of the Nile River on a world map. Begin the discussion by brainstorming the reasons for forming a settlement on or near a major waterway.

The Nile is the world's longest river. It is 4,160 miles long, and one of the world's few northward flowing rivers. It has two sources. One, the White Nile, starts deep in central Africa. The other, the Blue Nile, springs from the mountains of Ethiopia. The white source keeps steadily flowing all year. The blue source changes regularly from a spreading flood each summer when the mountain snows of Ethiopia melt, to a trickle the rest of the year. If the White Nile were the only water source, Egypt's soil would have been worn out long ago. If the Blue Nile were the only source, Egypt's soil would be nourished with fresh muddy flood water every summer (the "milk of the Nile"), but for the rest of the year it would be practically dry. The combination of these two rivers creates the fertile Nile valley. The Egyptians thought of the year as divided into three seasons of about four months each: *coming forth, or flood time*, when the Nile flowed muddy; *cultivation*, when the fields were planted and a more subdued Nile flowed clear; and *drought*, when the crops were harvested and the Nile, discolored with algae, flowed green.

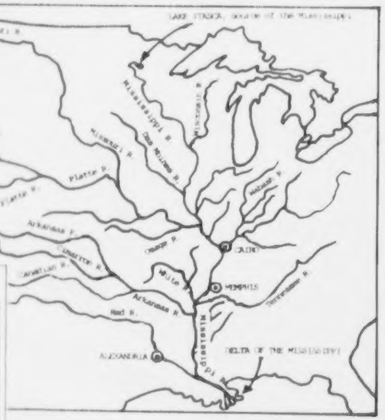
Because the Egyptians depended for life on the flow of the Nile, they had to find a way to control it. They learned to capture the flood water from the Nile in large, shallow storage basins, and then to draw this off through a system of canals, so that large stretches of otherwise dry land could be watered.

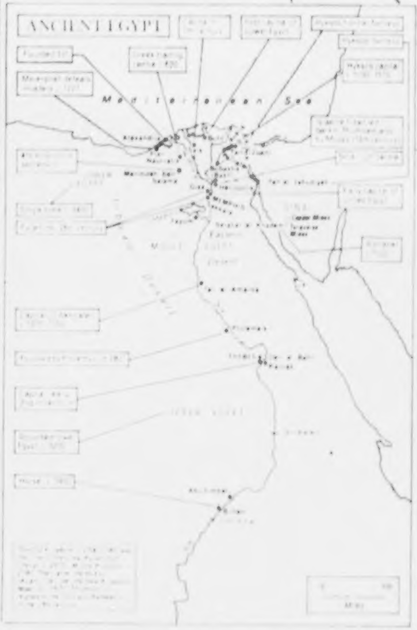
The Nile was also used as a means of transport for the Egyptian people, and it played a major role in the building of the pyramids. The massive granite stones (some weighing as much as 5 tons) were transported six hundred miles from the south on large barges during the flood season. The Nile was also used to level the ground for the base of the pyramids (see illustration). This lengthy process produced a perfectly flat surface of over a half a million sq. feet. The Egyptians no longer use the Nile for building pyramids, but it is still vital to the prosperity of their country.

WORKSHEET NO. 5

Name ____________________ Date ____________

Directions: Compare the drainage basin of the Mississippi River (right) with that of the Nile River below. Then answer the questions which appear on the right-hand side of this page. (Use the reverse side of this page to record your answers.)





Q.1 What accounts for the differences in the number of smaller streams feeding into each main river?

Q.2 A big desert lies on each side of the Nile. What does this tell you about Egypt *millions* of years ago?

Q.3 Cairo, Memphis and Alexandria are place names which occur on rivers of both countries. In which states are these cities located in the U.S.?

Q.4 The deltas of both large rivers seem equal in size, yet they differ in what they produce for market. Look up resource maps in an atlas. What are reasons for the differences?

Q.5 Religion has played a large part in developing both regions, along the Nile and the Mississippi. Why do you suppose that Egypt, which has been under Roman, Greek, Arab and other rulers over the centuries, now has almost a single state religion, while the U.S. has an almost infinite variety of faiths represented?

Q.6 Are the rivers used in about the same ways? Name some similarities and some differences.

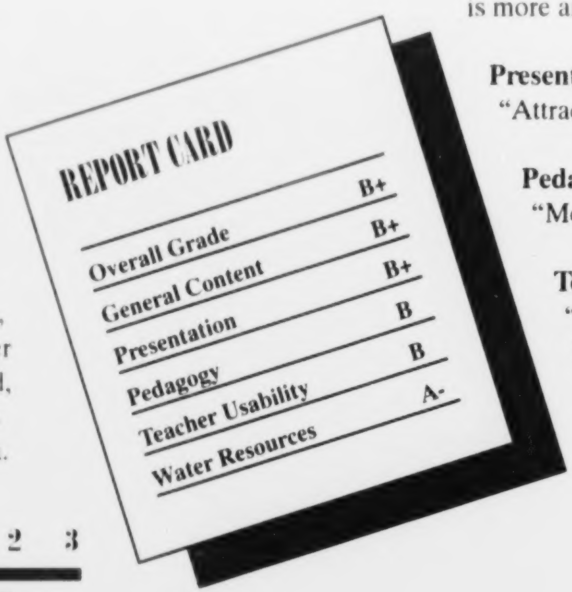
Q.7 It is said that Egypt is the only desert culture in history which has survived. Much of the southwestern U.S. is very nearly desert land, with serious water problems. Do you think we will be able to prevent true desert wastelands from developing within our heavily populated areas? How?

Every Drops Counts

Modesto Irrigation District
1231 Eleventh Street
P.O. Box 4060
Modesto, California 95352
(209) 526-7390

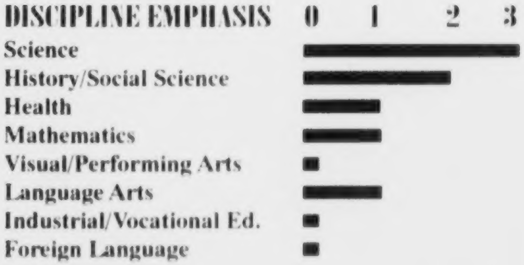
No charge. 1991. 61 pages.

The eight chapters in "Every Drop Counts" offer background information and seven junior high level activities. Topics range from the properties of water and the water cycle to water supply and distribution, water quality, and conservation. Water problems in California are highlighted, and one section specifically addresses water distribution in the Modesto area.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B
Teacher Usability	B
Water Resources	A-



COMMENTS

General Content
"Good overview of water and water issues." "'Every Drop Counts' is more an activity book than a curriculum."

Presentation
"Attractive and easy to use."

Pedagogy
"Most activities are designed for individual student work."

Teacher Usability
"Labs are easy ... somewhat elementary." Necessary equipment and materials are easily accessible.

Specific Content on Water Resources
"Good coverage of California's water supply history." Some of the material is specific to Modesto.

301

305

ACTIVITY 4B

Name

Period

Date

Evapo“rate”

We have learned that water exists in three phases: When water freezes, it exists as a solid. If enough heat is added to ice, the solid is converted to liquid. When enough heat is added to liquid water, it is converted into an invisible gas.

The process of converting water from a liquid to a gas is evaporation. We know that **temperature** affects the rate of evaporation. The greater the temperature, the faster the rate of evaporation. Are there other factors that affect the rate of evaporation?

Would the shape of the container that water is stored in affect the rate of evaporation? To find out the answer, let's set up an experiment.

Materials

1. Waterproof containers with at least a 300-ml. capacity, such as milk cartons, beakers, glasses, plastic beverage containers, soda bottles of various shapes and sizes
2. One 500-ml. measuring beaker with volume markings
3. Graduated cylinder.

Procedure

1. Divide into groups. Each group will use a different shaped container.

2. Find the area of the opening of your container. *Area = Length x Width*

If your container is round: *Area = 3.14 x Radius x Radius*

3. Carefully measure 300 ml. of water. Pour it into your container.

4. Place all containers in the same place in the classroom.

5. For the next five class days, carefully measure the volume of water in your container each day. To do this, *carefully* ***pour the contents of the container into the beaker. Record the results and carefully pour the water back into the container.***

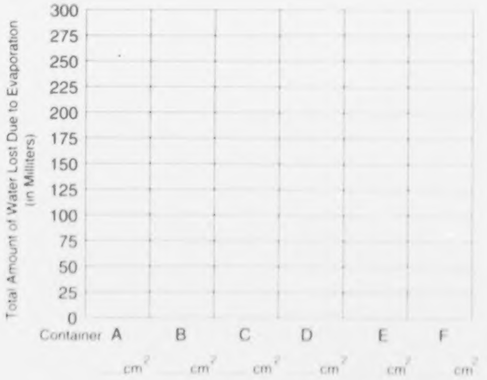
6. Set up a data sheet and record all groups' results each day.

7. Record the measurements from all groups' containers somewhere in the classroom where everybody can see the results.

DATA

		Volume of Remaining in milliliters					BV - EV = TE		
Container	Area	Day 1	Day 2	Day 3	Day 4	Day 5	Beginning Volume	Ending Volume	Total Evaporated
A	cm^2								
B	cm^2								
C	cm^2								
D	cm^2								
E	cm^2								
F	cm^2								

GRAPH YOUR RESULTS



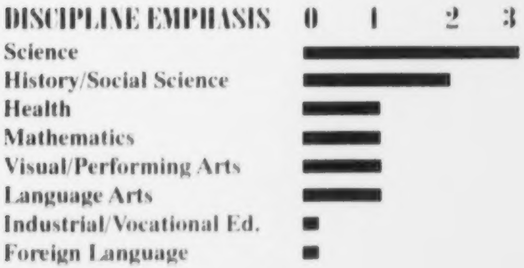
Conclusion:

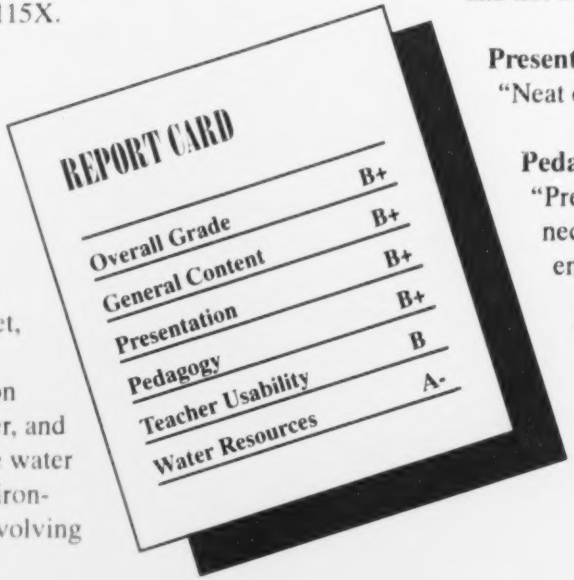
Understanding Our Environment

National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3000
(800) 722-6782

$35.00. 1995. Box format. Item PB115X.

"Understanding Our Environment" consists of eight books and support materials including color transparencies and posters packaged together in one box. One unifying project, supported by a collection of activities is presented in each of seven units entitled The Planet, Air, Water, Land, Life, People, and Challenges. The water unit focuses on the water cycle, sources of fresh water, and water quality. Specific issues include water pollution and preservation of the environment, culminating with an activity involving the study of a local waterway.





REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B+
Teacher Usability	B
Water Resources	A-

COMMENTS

General Content
"Offers water material that is linked to air and geology... compact and not overwhelming."

Presentation
"Neat extras (maps, satellite images, population information)."

Pedagogy
"Presented as 'information download' - a series of unconnected topics." "Personal water use is presented in a strong environmental education format."

Teacher Usability
"Materials could be easily integrated into an established curriculum. The simulation, 'The Clean Water Challenge' is well done."
"If a local waterway is not available, a large portion of the activities will not be usable."

Specific Content on Water Resources
"Water is one part of an eight book set." Thorough coverage of the water cycle and water pollution.

309

303

Project Part 3:
Survey of a Local Waterway

What do we mean when we say that water is polluted? Today, we frequently learn about water pollution through the media. We hear people talking about polluted water.

Is pollution simply a matter of the water being dirty, smelling bad, or being a strange color? Or is water polluted when people cannot use it for drinking or for other domestic and commercial purposes?

Is polluted water safe for animals, insects, and plants? Or is water polluted when animals, birds, and fish cannot drink it or live in it?

How do you describe water pollution? Write your ideas down and compare them to your classmates ideas.

A Freshwater Quality Survey

In this field activity, you will visit a local site and investigate its ecology and water quality. This site may be part of the same stream or river that you studied in Project Parts 1 and 2, or it may be a nearby canal, pond, or marsh.

The following questions will direct your initial investigation. Your teacher will assign more specific duties and may divide the class into groups.

Pond with Cattails

What Kind of Site Is It? Start by observing the site and taking notes about what you see. Look over the questions from the sample report to get some ideas about the important features of the water.

- Write a brief description of the area.
- Draw or photograph the site's main features.
- Prepare a sketch map of the environment using the grid on page 42 as a base for your map.

How Is the Water Used? Make a list of all the ways the water at the site is used. If it is a stream or river, try to take into account what happens to the water upstream and downstream from your survey site. Include uses like swimming, boating, and fishing, but remember that people are not the only ones who use the water.

310

To investigate water pollution, you will need to decide if the water quality is suitable for the uses to which it is put. Make a table similar to the one that follows.

Some General Questions for Your Report

Here are some questions your class will consider for your water-quality report:

- What color is the water?
- What does the water smell like?

- Where does the water come from?
- Where does the water go?

- How deep is the waterway?
- What is the distance across it?
- What temperature is the water?
- How fast is the water moving?

- Do you see any green slime? Estimate how much there is.
- Do you see any brown slime? Estimate how much there is.

- Are there plants growing in the water? List the plants that you recognize and write descriptions of others so you can identify them later using the class's field guides. Use the grid system described below to record the location of the plants that you see.

- Are there animals in or near the water? Identify the organisms you can see. Use the same grid system to count these organisms and locate their habitats in the waterway. Bring back a sample of water so you can use the microscope to look for microorganisms.

- Are there any signs of scum, froth, or oil in the water or on the banks? Can you tell where it is coming from?
- Is there any rubbish in the area? Identify the types of rubbish and estimate how much of each type is present.

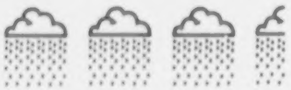
- Which fish are living in the water? Where did you get your information?
- Are there birds at or near the site? Identify them. Describe how they use the waterway.
- Are reptiles living at the site? Try to identify them. Describe how they use the site.

- Are there signs of vandalism?

311

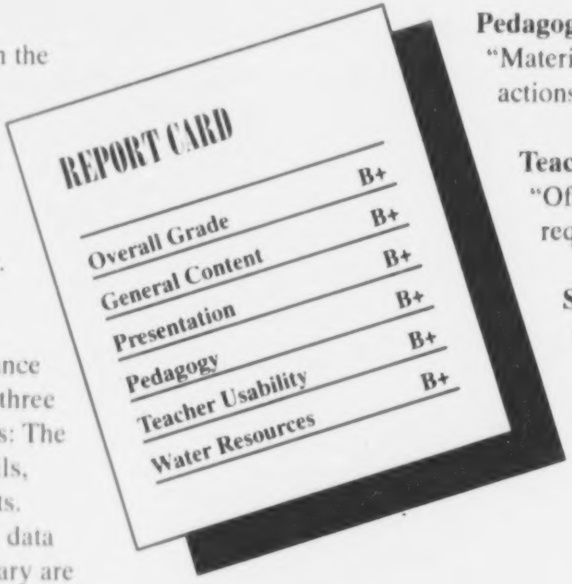
Groundwater: A Vital Resource

Tennessee Valley Authority
Water Quality Department Library
1101 Market Street, 2C Haney Building
Chattanooga, Tennessee 37327
(423) 751-7338



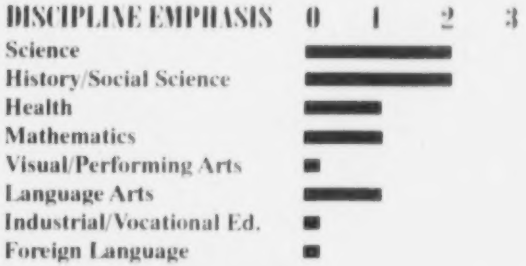
Publication is no longer available from the Tennessee Valley Authority. Limited copies are available from the Department of Water Resources [(916) 653-1097] which has been granted permission to reprint the material for educational purposes only.

"Groundwater, A Vital Resource" (61 pages) focuses on the role and importance of groundwater and aquifers. Twenty-three activities are organized in four sections: The Water Cycle, Water Distribution in Soils, Water Quality, and Community Impacts. Background information, reproducible data sheets, groundwater maps, and a glossary are provided.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B+
Teacher Usability	B+
Water Resources	B+



COMMENTS

General Content
A good basic groundwater curriculum.

Pedagogy
"Material is fact-based ... not connected to concepts or direct actions."

Teacher Usability
"Offers good background information." Some activities require access to a stream.

Specific Content on Water Resources
Good coverage of groundwater issues including agricultural run-off, landfill leachate, saltwater intrusion, and groundwater rights.

POROSITY AND PERMEABILITY

GRADES 7-12

OBJECTIVE

To study some characteristics of clay, sand, and gravel related to groundwater by measuring (a) pore space, and (b) permeability

PREPARATION (BACKGROUND INFORMATION)

The porosity of a rock or rock material tells you how much of its volume is open space. The permeability of a rock is its ability to transmit water or other liquids. Both porosity and permeability are important in relation to groundwater

MATERIALS

—gravel (or marble chips)
—sand
—clay
—small test tubes
—gas bottles
—funnels
—filter paper
—glassmarking crayon
—test-tube rack
—holder for funnel (ring stand and ring, or tripod)

PROCEDURE

1. Measuring pore space in gravel, sand, and clay

With a soft crayon or piece of scotch tape, place a mark about halfway up the sides of a small bottle, beaker, or test tube. Fill the bottle to the mark with water, and then measure the volume of water in a graduated cylinder. This is the volume of that part of the bottle. Record this in the "Total Volume" column of the table below. Dry the bottle.

Now fill the bottle up to the mark with gravel (or marble chips). Fill the graduated cylinder to its top mark with water. Slowly and carefully, pour water into the gravel until the water just reaches the top of the gravel. Note the volume of water used to saturate (fill the pores of) the gravel. Record it in the table under "Pore Space." Divide this by the total volume to compute the percentage of ore space in your sample of gravel.

Repeat the experiment with sand and record your results.

Try the experiment with clay. What happens? ____________________

____

____

What causes this? ____________________

____

____

____

MATERIAL	TOTAL VOLUME	PORE SPACE	% PORE SPACE (Porosity)
Gravel			
Sand			
Clay			

2. Measuring Permeability of gravel, sand, and clay

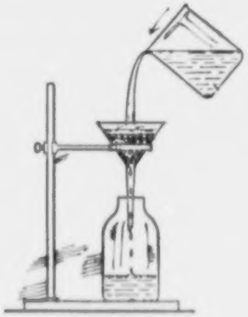
Fold a circular filter paper into quarters, open it into a cone, and insert it into a small funnel. Fill the cone with gravel (or marble chips) to about half an inch from its top. Place the stem of the funnel just inside a small test tube or small gas bottle. Note how many seconds it takes to fill the test tube or gas bottle with water by pouring water through the gravel. This can be done either with a watch or by careful counting.

Repeat the procedure with sand.

Try the experiment with clay. What happens? ____________________

____

____



MATERIAL	NUMBER OF SECONDS
GRAVEL	
SAND	
CLAY	

California's Water Problems

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

$20.00. Revised in 1996. Package format.

"California Water Problems" offers four role-playing scenarios based on water management case studies: the Delta Dilemma, the Kesterson Clean-Up, the Colorado River Cut-Back, and Groundwater Worries. Students are given the opportunity to develop research skills and participate in cooperative learning exercises. Materials include the Teacher's Guide (60 pages), Layperson's Guide to California Water (24 pages), Layperson's Guide to the Delta (20 pages), Layperson's Guide to Agricultural Drainage (16 pages), the California's Water System poster, the California Water Map, and the Colorado River Water Map.

REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	B+
Teacher Usability	B-
Water Resources	B+

COMMENTS

General Content
"An incredible resource: history, games, issues, simulations, pamphlets." "A good way to start a unit on California water."

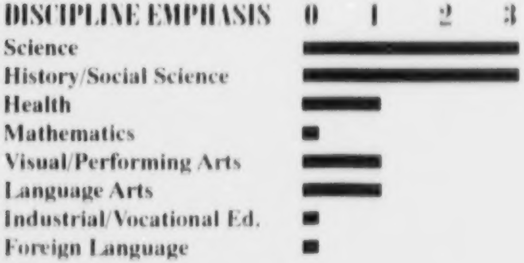
Presentation
"Layout requires some digging to determine what the teacher is looking at." "Accompanying posters are well done."

Pedagogy
Maps provide a springboard for student activities.

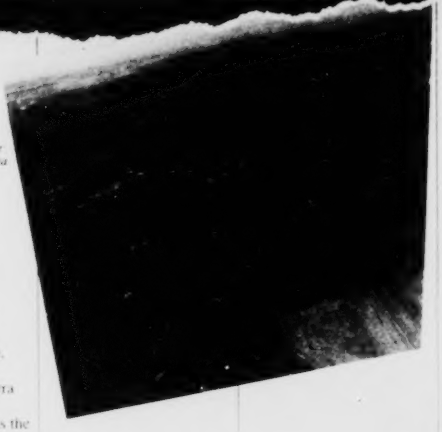
Teacher Usability
The Layperson's Guides provide a thorough background for the teacher. The emphasis is placed on water information, not student activities. As such, it is not classroom-ready.

Maps are available in Spanish.

Specific Content on Water Resources
"Very specific to California." Controversial, sociopolitical water issues are addressed.



PART I - THE DELTA DILEMMA



Aerial view of the San Joaquin Delta

Flowing south, fed by the northern Sierra Nevada, the Sacramento River meets the northbound San Joaquin River to form the Sacramento-San Joaquin Delta in the Central Valley. The two rivers mingle with smaller rivers to form a 700-mile-long maze of rivers and sloughs surrounding 57 islands, many of them agricultural.

Their combined fresh water flows then roll on through the Carquinez Strait, a narrow break in the Coast Ranges, and on into San Francisco Bay's northern arm. Suisun Marsh and adjoining bays are the brackish transition between the freshwater flowing from the rivers and the salt water of the Bay.

The area has always been at the mercy of river flows and tides. Even before humans changed the Delta environment, salty ocean water from San Francisco Bay crept up Delta channels during dry summers, when mountain runoff slowed down. Then, during the winter, heavy runoff from the mountains kept the sea water out of the Delta. Upstream dams, including giant Shasta, help control this problem today.

The Delta, as we know it, is largely a human invention. Early explorers found a vast mosquito-infested tidal marshland covered with bullrushes called tules. Later, trappers took advantage of the abundant wildlife. They were followed by farmers, some of them unsuccessful gold-seekers, who discovered wealth of another sort: fertile soil. Progressively higher levees were built to keep the surrounding waters out, lands were pumped dry, and what once was uncontrolled marshland was transformed into productive farmland.

OBJECTIVES

Students will be able to:

1. Collect information about the problem, organize it, state their position, listen to the positions of others, and reach a compromise agreement.

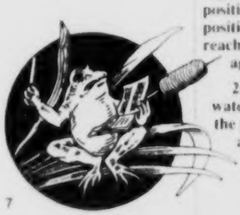
2. Conclude that water is a resource of all the people of California and must be managed for the benefit of all.

3. Discover that decisions about the environment are difficult and that many viewpoints and interests must be considered.

4. Describe the complex environment of an estuary.

5. Explain where the water in their community comes from.

6. Describe how toxic pollutants endanger California's water supply.



THE DELTA DILEMMA

No other single area is quite as crucial to the state's overall water picture as the Delta – it forms the cornerstone of California's two largest water projects. Its existing channels are used to transport water to the federal and state pumps in the southern Delta. From there water is channeled south and west through canals and aqueducts to the south Bay area, agriculture-rich San Joaquin Valley and an estimated 18 million urban Californians, mostly in Southern California.

Water also flows west through the Delta and San Francisco Bay to the ocean, holding back the salt waters of the Bay and protecting water quality for consumption, recreation, and fish and wildlife. With brackish marshes and San Francisco Bay, the Delta forms part of an estuary and an important habitat for millions of migrating wildfowl, fish and other fauna and flora.

The Delta has gained considerable notoriety over the years as conflicting geographic areas and interests vie for more water. Setting quality and flow standards for the Delta and issuing water right permits have been ongoing responsibilities of the State Water Resources Control Board (SWRCB). As knowledge and understanding of this complex region have increased, these decisions have been challenged, updated, and amended. For several years, starting in 1987, the SWRCB will be conducting hearings to deal with problems exactly like the ones proposed in this unit.

THE PLAYERS

1. Director of the California Department of Water Resources

2. Regional Director of the U.S. Bureau of Reclamation

3. Director of the California Department of Fish and Game

4. General Manager of the Metropolitan Water District of Southern California

5. General Manager of the State Water Contractors

6. Manager of the Kern County Water Agency

7. Senior Researcher for the Bay Institute of San Francisco

8. Attorney for the Environmental Defense Fund

9. Director for the Central Valley Project Water Users Association

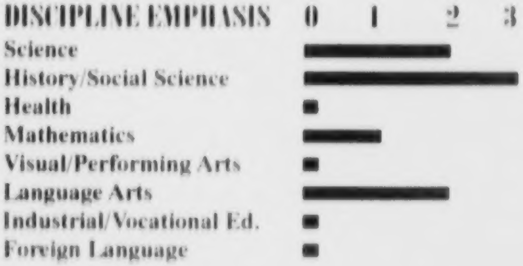
Recreation in the Delta

Down the Drain

Massachusetts Water Resources Authority
100 First Avenue
Boston, Massachusetts 02129
(617) 241-6259

No charge. 1992. 111 pages.

"Down the Drain" introduces students to wastewater treatment processes and the importance of personal responsibility in the resolution of water pollution problems. Laboratory demonstrations, role playing activities, historical research studies, and hazardous materials inventories are described in the curriculum guide. Although the narrative is based on the Boston Harbor Project, the activities are readily adaptable to other regions.



REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	B
Teacher Usability	B
Water Resources	B+

COMMENTS

General Content
"This provides good information about hazardous products commonly used in the home, safer alternatives, and wastewater treatment."

Pedagogy
"Great conceptual learning ... includes action-oriented activities." "Real-life connections are made."

Teacher Usability
"Simple materials are needed." The recommended support materials such as videos are available through the Massachusetts Water Resources Authority and, thus, not readily accessible to California educators.

Specific Content on Water Resources
Specific to the Boston area. "Good wastewater management resource data." "In-depth explanations of current and historical sewage treatment."

Lesson 4 consists of two independent activities. Lesson 4(a) compares the wastewater histories of Boston and London. Lesson 4(b) on page 4-13 compares Boston's wastewater issues of today with those of a century ago.

▶ About this section...

The study of the wastewater treatment process and the Boston Harbor Project is often thought of as strictly science related. However, this topic expands into many different areas including history, English, government studies, current affairs and health.

These next activities help students realize that these issues affect their lives every day and will affect the lives of future generations just as they have affected their forefathers.

These activities do not attempt to give "right" and "wrong" answers. Their purpose is to stimulate students to think about important issues.

Lesson 4(a)

▶ Purpose:

To point out that sewerage systems and wastewater treatment are an important element of the infrastructure of developed areas around the world.

▶ Lesson in brief

Students read about Boston's sewerage system and London's system and note the differences and similarities.

▶ Key words

Cholera Infiltration Inflow I/I Midden

▶ Materials

Student Packet 1 - Taken from: "**Restoration of Sewerage Systems (The Assessment of the Problem in the UK**").
Student Packet 2 - "**A Look Back at Boston's Sewerage System**" &
"**How We Operate One of The Oldest Sewerage Systems in America**"
Current newspapers and magazines.

▶ Time required

Homework assignment plus one or two class periods for activity

---

Student Packet 1 - London

Directions: Read the two excerpts listed below, the first one written in 1878 about the London Sewer System and the second one written in 1990 about the Boston Sewer System. Continue reading about the London Sewer System and be prepared to discuss issues tomorrow with your classmates who are reading about the Boston Sewer System.

Excerpt 1:

The Boston Transcript, January 7, 1878

SEWAGE IN THE HARBOR

The failure of the new sewerage system of London (on which our projected three-million-dollar improvements is modelled) to get rid of the sewage...

Not even the views of engineering authorities if they are prepossessed or committed in favor of the scheme, should be permitted to go on and make the harbor, which is our great local source of health and pleasure, and our main reliance for the business future of the city, the constant stink and cesspool, with growing shoals in new places, that the Thames is becoming under this system according to unimpeached testimony.

... the sewage let out on each tide reaches the neighborhood of the lower light, and would, "on its return with the flood tide, be so diffused as not to be perceptible," Engineer Clark thinks. It is precisely on this lattle (sic) point that the actual experience of the London sewage has disappointed the engineers' theory of "diffusing." It does not "diffuse" "worth a cent."

Excerpt 2:

"How We Operate One of The Oldest Sewer Systems in America". Massachusetts Water Resources Authority, 1990.

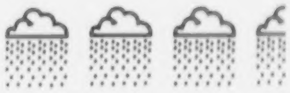
...Digested sludge has been discharged into Boston Harbor on the outgoing tide since the Deer and Nut Island plants opened. The theory was that the force of the tide would carry the sludge away and disperse it. One look at the harbor today disproves that theory; it is estimated that at least 20 percent of the sludge returns on the next tide...

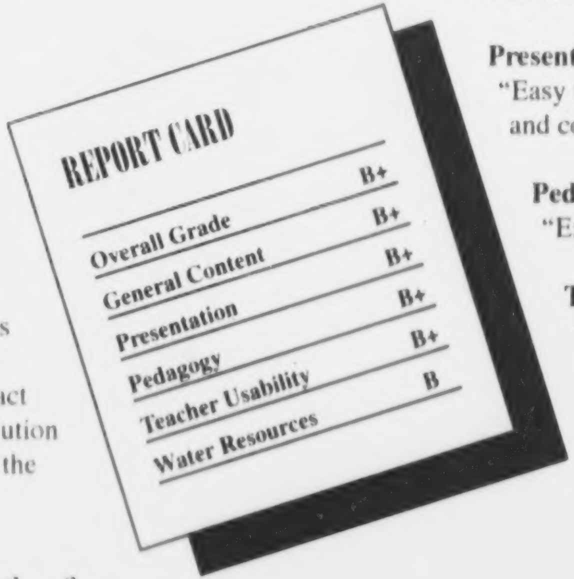
Project Water Science

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

$ 20.00. 1995. Package format.

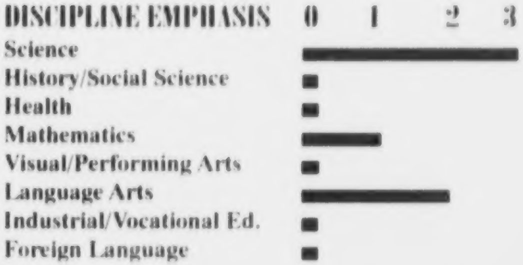
"Project Water Science" is a collection of water education materials designed as a water chemistry unit of study. The Teacher's Guide (39 pages) offers hands-on activities that focus upon water quality, water and the environment, and water and people. Materials also include the Layperson's Guide to Drinking Water (20 pages), a Water Fact Card, a pull-out Nonpoint Source Pollution Game, the California Water Map, and the California Waterways Poster.





REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B+
Teacher Usability	B+
Water Resources	B



COMMENTS

General Content
"A good supplemental piece - a water sampler." "Offers a series of lab activities to be used in physical or earth science."

Presentation
"Easy to use, attractive format." "The student material is clearly and concisely written."

Pedagogy
"Excellent lab studies covering many appropriate topics."

Teacher Usability
"The lab activities are good starting points for further explorations."

Specific Content on Water Resources
California water supply and water use issues are covered thoroughly.

324

325

SECTION 1

Water Quality

Teacher's Information Labs 1-5

LAB 1
HOW LOW CAN YOU GO?
Groundwater and Porosity

Objective

Students will become aware of some of the pressing issues involving contamination of our limited surface and groundwater supplies.

Demonstration materials needed

1. large glass bowl, jar or fish tank
2. glass beads, fish tank rocks or sand
3. food coloring

Lab Hints

Use pea-size gravel, fine sand, and soil typical in your area.

Activity

1. Introduce this learning unit with the Reading and by referring to recent news articles regarding water quality problems. Ask the students if they are aware of any pressing local water quality issues.

2. Hand out photocopies of the *Layperson's Guide to Drinking Water* p. 2. Promote discussion about the issues.

3. Using a glass bowl, a large jar or fish tank, simulate a ground water basin by adding sand, or gravel and fish tank rocks or another medium like glass beads. By adding a measured amount of water, students can observe recharge, withdrawal and water filling the crevices. Using a straw to simulate a well, siphon out water (or use aspirator) and note the water level on the side of glass bowl, jar or fish tank with a grease pencil. A cone of depression should be formed if particles are small enough and extraction is large enough.

Extension Activity

Suggest that some of the groups change the proportion of sand to gravel to soil. Discuss how the pore size may change with the mixture. Ask what would happen if the gravel was angular as opposed to round.

LAB 2
TO SUDS OR NOT TO SUDS
Water Hardness

Objective

Students will evaluate the hardness of tap water and recognize hardness as an important factor in water quality.

Lab Hints

Small jars like baby food bottles may be used if test tubes are not available. Use liquid soap, not detergent. For the mystery sample, add a handful of Epsom salts to a liter of tap water. Epsom salts contain magnesium, and will make the sample a good example of hard water.

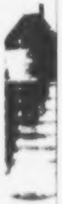
Extension Activities

See if students can design another lab to test hardness. This could be washing an oily rag in different types of water. Also suggest one group use detergent for the initial experiment. Discuss how water softeners work. Show the build up of scale in a tea kettle or hot water pipe. Invite a local plumber in to talk about scale and water softeners.

LAB 3
HOW DOES IT TASTE?
Is Bottled Better?

Objective

Students will recognize taste as a criterion of water quality.



Reading

Have students read pp. 12—13 in *Layperson's Guide to Drinking Water*. These pages may be photocopied.

Lab Hints

Collect water from various sources (tap, distilled, bottled spring, carbonated, etc.) and put into plain bottles labeled with a number. Have unsalted soda crackers available to eat between samples to remove tastes from mouth.

Extension Activity

Have students test water samples for hardness. Relate mineral content to taste.

To Suds or Not To Suds

LAB 2

Water Hardness

Introduction

One of the characteristics of water quality is its hardness, which refers to the amount of minerals dissolved in it. These minerals include calcium and magnesium. Hard water has many dissolved minerals, which interfere with its usefulness in washing. The minerals react with soap to form scum instead of suds. These minerals can also form a deposit called scale inside boilers and hot-water pipes.

Question

How hard is our tap water?

Materials

test tubes
soap solution (not detergent)
glass markers or crayons
water solutions: distilled, tap, bottled spring, salt
mystery water sample

Procedure

1. Pour 5 ml. of distilled water into a test tube. Add 1 drop of liquid soap solution, cover tube with thumb, and shake. Continue adding drops of soap solution until you have lasting suds. Shake vigorously after each drop. Use this as a control.

2. Repeat procedure with other water samples. Use a clean, labelled test tube for each sample. Record the number of drops of soap solution necessary to produce lasting suds.

Hypothesis

____

____

Results

1. Is your tap water hard or soft?

____

____

2. Which was the hardest water?

____

Which was the softest?

____

3. Was there any cloudiness in any of the water samples after adding soap? ______________ What do you think this is?

____

____

____

4. Which would be better for washing clothes, distilled water or salt water? ______________ Why?

____

____

____

Data

distilled water	drops
tap water	drops
bottled spring water	drops
salt water	drops
mystery water sample	drops

Conclusion

____

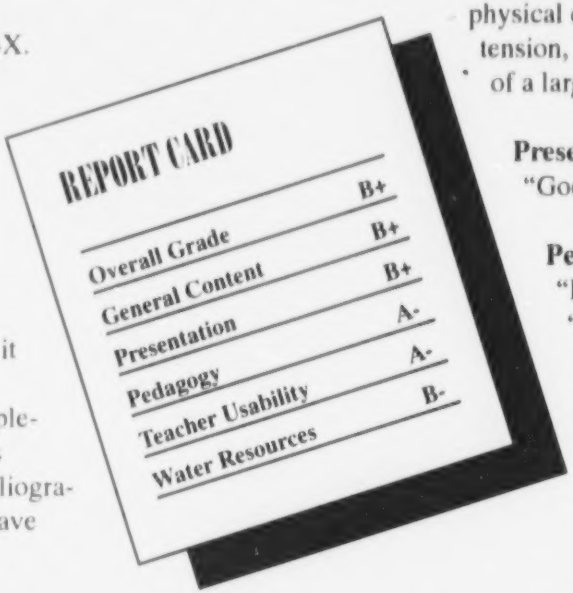
____

Project Earth Science: Physical Oceanography

National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3000
(800) 722-6782

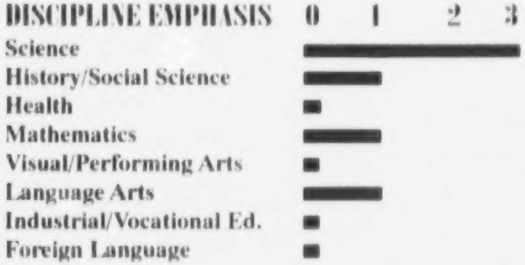
$21.95. 1995. 224 pages. Item PB114X.

Part of the Project Earth Science series, "Physical Oceanography" focuses on the uniqueness of water, the forces that affect its movement, and the human impact upon the Earth's ocean. Due to its emphasis on the chemical structure and physical characteristics of water, it was included in this compendium. Eighteen hands-on activities are complemented by five readings. Appendices include a materials list, annotated bibliography, and instructions to construct a wave tank.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	A-
Teacher Usability	A-
Water Resources	B-


DISCIPLINE EMPHASIS

COMMENTS

General Content

"This offers 18 activities with readings and apprendices focued on physical oceanography." "Good for studying waves, surface tension, salinity, and physical properties of water." "A useful part of a larger water unit."

Presentation

"Good eye appeal."

Pedagogy

"Easily adapted to fit into existing curricula." "Challenging content."

Teacher Usability

"Offers high quality reading and an excellent bibliography." A useful resource for physical oceanography, not environmental education.

Specific Content on Water Resources

Focuses on physical oceanography, not freshwater resources. Discussions of human pollution of oceans are included.

A Pile of Water

Background

We observe and use water every day. It makes life on Earth possible. Water covers nearly three-fourths of Earth's surface and affects almost all living and non-living things. Because it is so abundant, it may not seem unusual, but water is unique when compared to other substances in the universe. As a matter of fact, its properties are quite different from those of other substances even here on Earth. For instance, it is the only substance on Earth that occurs naturally in all three states—solid (an iceberg, for example), liquid (ocean water), and gas (steam or vapor). See Figure 1.

Every substance (water, air, dirt, etc.) is made up of atoms. Atoms are arranged in a specific way, forming a **molecule**. The make-up of a water molecule—or any molecule—is called **molecular structure**. A substance's molecular structure is responsible for its properties and governs how it interacts with other things on Earth. This activity introduces and explores one specific property of liquid water.

Objective

The purpose of this activity is to investigate a specific property of water: its ability to "stick" to itself.

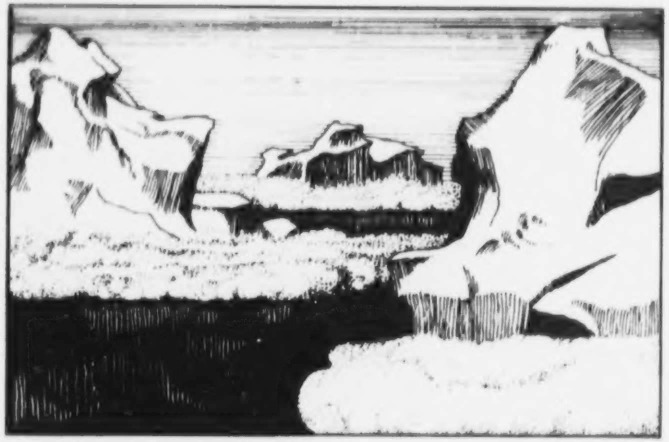
Vocabulary

Molecule: The most basic unit of a substance; it has a specific arrangement of atoms.

Molecular structure: The arrangement of atoms in a specific molecule.

Figure 1

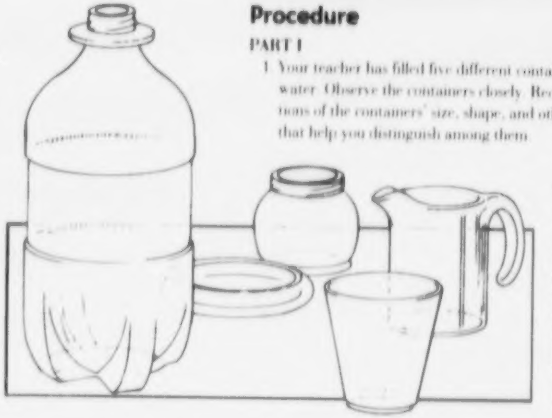
In areas like this arctic region water can often be found in all three states.



Procedure

PART I

1. Your teacher has filled five different containers with colored water. Observe the containers closely. Record brief descriptions of the containers' size, shape, and other characteristics that help you distinguish among them.



2. Predict which of the five containers will be able to withstand the addition of the greatest number of pennies without spilling over. Record your prediction in Table 1.
3. Estimate the number of pennies that would have to be added to each container to make it spill over. Record your estimates in Table 1. You will have a chance to revise these estimates in step 7 of Part II.

PART II

Before you check your predictions, explore the behavior of water with a single coin.

1. Place a penny on a piece of paper towel.
2. Estimate the number of water drops you can pile on the penny before the water runs over its edge. Record your estimate in Table 2.
3. Test your estimate by placing water on the penny drop by drop. Working with the other members of your group, develop a technique that allows you to put the most drops on your penny. You may want to put the drops on at different areas of the penny or from different heights. Count each drop until the water spills over. Record your results in Table 2.
4. Make a sketch of the water on the surface of the penny just before the water spilled over.
5. Based on what you observed with the penny, make a hypothesis comparing the number of drops that could be piled on a nickel, dime, or quarter.

Materials

For each group (class will be divided into five groups):

◇ 1 of 5 containers varying in shape and size of opening

◇ several rolls of pennies

For each student:

◇ penny

◇ eyedropper

◇ small beaker or clear plastic cup (may be shared)

◇ paper towel

◇ other assorted coins (quarters, nickels, etc.)

GRADES 7-9

BEST COPY AVAILABLE

Learning To Be Water Wise and Energy Efficient

National Energy Foundation
5225 Wiley Post Way, Suite 170
Salt Lake City, Utah 84116
(801) 539-1406

Prices vary (approx. $20.00 - $30.00 per student/household). 1995. 177 pages. Only available as part of the Water Wise and Energy Efficient program. Corporate sponsorships are frequently available.

One teacher's guide, 24 student workbooks, a Home Retro Kit of energy- and water-saving devices including a high efficiency shower head, sink aerator, compact fluorescent lamp, and lawn watering rain gauge, and an 18-minute video on installation techniques combine to create the "Learning To Be Water Wise and Energy Efficient" package. Twenty-one instructional activities and accompanying posters are provided in the teacher's guide, focusing on water and energy efficiency through classroom instruction and the use of the devices installed in each students's home.

REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	A-
Pedagogy	A-
Teacher Usability	B
Water Resources	B

COMMENTS

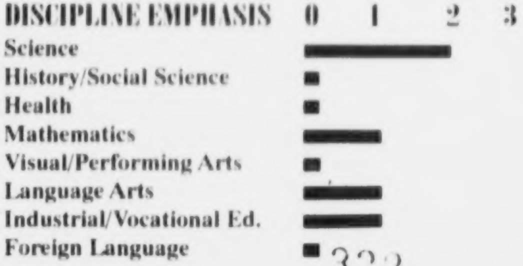
General Content
"A colorful, attractive, and engaging curriculum, clearly suited for middle grade students." "Good experiences for personal water usage."

Presentation
"Nice water charts." "The video is informative and humorous." "Materials are overpackaged."

Pedagogy
"Students and parents work in meaningful, active conservation of water and energy."
"Some of the information is oversimplified."
"Many activities are action-oriented."

Teacher Usability
Both money (or a sponsor) and parental involvement are required.

Specific Content on Water Resources
Limited scope: home water conservation.
"Only one-third of the material focuses on water; the rest is on energy."



DOWN THE DRAIN

Activity Five

If you're an average person, you probably use about 300 gallons of water in your home each day. That's each day — not each week or month. Just this year alone, you personally will have used something like 109,500 gallons of water!

Most of the water you use gets flushed down the toilet or goes down the bathtub drain. Don't believe it? Keep track of how much water your family uses in the bathroom by completing the following activities.

Shower

Keep a pad of paper in each bathroom. Ask the members of your family to jot down each time they take a shower and the length of the shower. You can figure out how much water your family uses to shower by doing the following math formula.

Minutes x 4 gallons = gallons of water used for each shower.

Add up your figures for each person and you get the total number of gallons of water used for showering. High efficiency showerheads can cut your shower water usage in half. If your family already is using one, divide your total in half.

Bath

Taking a bath uses more water than taking a shower. When you take a bath, you use about 30 to 40 (35 average) gallons. Do the following math formula to figure out how much water your family uses to bathe.

Number of baths x 35 gallons = gallons of bath water used.

Toilet

Each time you flush the toilet you use between five and six gallons of water. Ask everyone in your family to make a check on the pad each time they flush the toilet. Keep track of the number of flushes in 24 hours.

Number of flushes x 5 gallons = gallons of toilet water used.

Toilet dams or restrictors placed inside your toilet tank can save up to 50 percent of the water used to flush. If your toilet has one, or your home has a high efficiency toilet, divide your usage in half.

Bathroom Sink

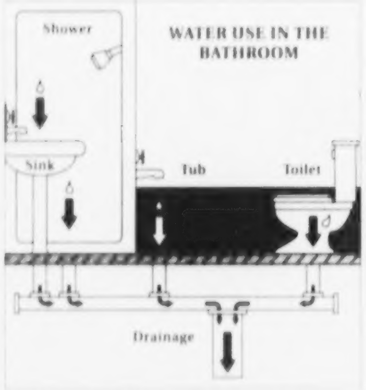
The average family uses between 2 and 15 gallons of water each day from their bathroom faucet. Figure your family uses the average, or 7.5 gallons of water with each faucet.

Number of faucets x 7.5 gallons = gallons of faucet water used.

TOTAL NUMBER OF GALLONS OF WATER USED IN THE BATHROOM EACH DAY:

Answer:

Depends upon students' homes.



Most water is used in the bathroom.

Mind Bender

It has not rained in your town for over three months. The government has issued warnings to conserve water. You need to cut your water consumption in half. How will you cut back? You still need to carry out all your daily activities. Make a water budget for yourself and your family. The budget should take account of all of the places where you use water inside your house and out — bathroom, kitchen, laundry and yard.

How will you use less water while still completing all your necessary jobs?

Over the weekend, see if you can actually stick to your water budget.

Water Words

We not only use water every day in our daily activities, we use it in our language as well. The dictionary lists over 100 words with "water" in them. Read the definitions below and see if you can name the "water" word that goes with each one.

1. A slow, powerful ox-like animal.
2. An insect that lives in fresh water.
3. A type of paint.
4. A white-flowered plant often used in salads.
5. A vinyl bag filled with water. People sleep on it.
6. A large fruit with a green rind and a pink pulp.
7. So snugly put together that water cannot seep through.
8. A material that keeps out water completely.
9. A toy that shoots water in a stream.
10. A hole from which water spurts.

Answer:

1. water buffalo 2. water bug 3. watercolor
4. watercress 5. waterbed 6. watermelon
7. watertight 8. waterproof 9. water pistol
10. waterspout

Write On

Take a hot bath one night before going to bed. Afterwards, write down a few notes about how the bath made you feel. The next night, take a cool shower. How did you feel? How did the bath compare to the shower? Did you feel more relaxed or less? Write a paragraph describing your different feelings. You might also want to discuss your thoughts with other classmates.

BONUS ACTIVITY

Glaciers and ice caps make up more than two percent of the earth's water supply. Scientists think someday we could use them as a source of fresh water. Would water from icebergs be too salty? Try this test to find out:

You will need:

Two 7 oz. paper cups	
Salt	**Freezer**
Teaspoon	**Water**

Fill the two cups with water. Dissolve 1/8 teaspoon salt in one cup and label it. Put both cups in the freezer overnight. Next morning taste the ice cubes from both cups. Break each cube in half. Taste the tops, bottoms, sides and middle. Where do you taste salt? Why?

Answer:

You can't taste the salt. Salt is heavier than ice and settles out.

© [illegible] National Energy Foundation. All Rights Reserved.

BEST COPY AVAILABLE

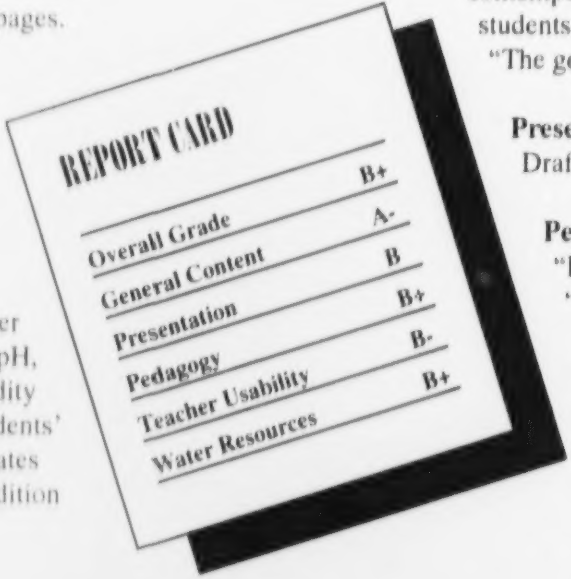
Aquatic Ecosystems

Adopt-A-Watershed
P.O. Box 356
Hayfork, California 96041
(916) 628-5334

🌧 🌧 🌧 🌧

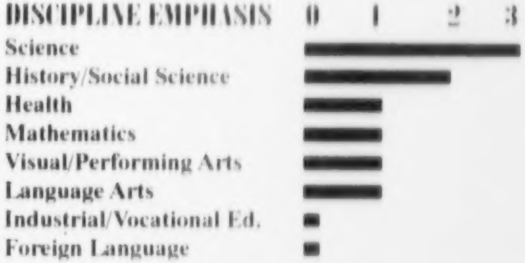
Price not yet established. 1995. 156 pages.

Focusing upon wetlands and creeks, "Aquatic Ecosystems" presents eight lessons on the ecological significance of these habitats within a watershed. Fish behavior, feedback loops, niches, and interdependence are explored both in the classroom and field. Water quality tests, including temperature, pH, dissolved oxygen, nitrates, and turbidity are conducted at a site within the students' adopted watershed. The unit culminates with a watershed art show. A draft edition was reviewed for the compendium.



REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B
Pedagogy	B+
Teacher Usability	B-
Water Resources	B+



COMMENTS

General Content

"'Aquatic Ecosystems'" includes extensive wetlands data in a contemporary approach." "Good ecosystems approach; emphasizes students getting out into the ecosystem they are studying." "The genesis of a fine idea!"

Presentation

Draft edition was reviewed.

Pedagogy

"I loved the assessments (portfolios and demonstrations)!" "The content is strong: thematic and interdisciplinary."

Teacher Usability

"Extensive teacher background and preparation effort are required."

Specific Content on Water Resources

"Specific to California." "Watershed and wetlands focus."

VALUE OF A LOCAL WETLAND

Student Activity Sheet

Name(s)______________________ Date______________

Summary Table for: ______________________
Name of the Wetland

Estimated Annual Values (Per Acre/1990$)

Wetland Function	**Low**	**Medium**	**High**
Flood Control	$260	$4,650	$4,650
Water Supply	$6,800	$6,800	$20,360
Water Quality	$3,360	$6,600	$10,400
Recreation	$67	$347	$6,060
Commercial Fisheries	$38	$199	$877
Habitat	$3,337	$3,337	$8,128
Total Annual Benefit Per Acre	**$13,862**	**$21,933**	**$50,475**

Wetland acreage for each level of function:

Annual Value of Wetland for each level of function (low, medium, high):

Total Annual Value of Wetland

YOUR WETLAND: HOW MUCH IS IT WORTH?

Student Activity Sheet

Name(s)______________________ Date______________

1. Read the two information sheets "The Value of California Wetlands: An Analysis of their Economic Benefits" and "Fisheries, Wetlands and Jobs."

2. Your group is going to calculate the actual dollar value of a wetland located in your adopted watershed. Look at the Summary Table titled "Value of California Wetlands." The value for each acre of wetland function has been calculated for the following:
   - flood control
   - water supply
   - water quality
   - recreation
   - commercial fisheries
   - habitat

   Also note that wetland function has been classified as low, medium, and high.

3. Select a wetland to investigate. In order to calculate its value, you will need to know how large it is. You will also need to now whether it is a high, medium, or low functioning wetland. Your first task will be to obtain this information. Follow these directions:
   a. First, your teacher will direct a student from your class to call the U.S. Fish and Wildlife Service's (FWS) Earth Science Information Center to obtain a copy or copies of a National Wetlands Inventory Map of your area (1-800-USA-MAPS). After locating wetlands in your adopted watershed, each of the groups in your class will select a different wetland to study.
   b. Next, you will need to obtain specific information about the wetland you selected. Where can you look? Perhaps there is a Visitor Center at the wetland site. Other places to look are the United States Fish and Wildlife Service, the Department of Fish and Game, the State Department of Parks and Recreation, or specific city or county governments. Your teacher will help you know which agency to contact. Select one member of your group to make the phone call or, better yet, visit the wetland as a group and talk to the resource personnel there. You will need to call ahead and make an appointment.
   c. Ask how many acres there are in the wetland. Then ask whether the wetland is low, medium, or high functioning. Perhaps part of the wetland acreage is low functioning and part is medium or high functioning. Get the numbers of acres for each level of functioning. They should add up to the total acreage of the wetland.

4. Now you know how many total acres there are in the wetland. You also know how many acres are high, medium, or low functioning. Refer to the data table on page 2 of "Fisheries, Wetlands and Jobs" and fill in your student activity sheet with the following information:
   a. Write the acreage of the wetland.
   b. Calculate the value for each of the categories in question two above.

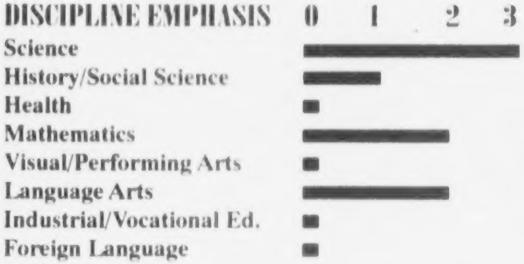
Copyright © 1995 Adopt-A-Watershed Program

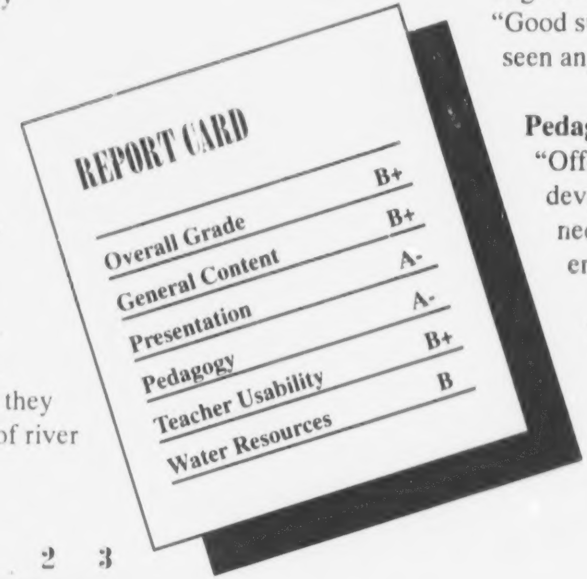
River Cutters

Great Explorations in Math and Science
(GEMS)
Lawrence Hall of Science
University of California at Berkeley
Berkeley, California 94720-5200
(510) 642-7771

$10.00. 1995. 84 pages.

"River Cutters" is one in a series of GEMS guides, a guided-discovery based curriculum project of Lawrence Hall of Science. Seven exploratory sessions introduce students to erosion, pollution, and the sequencing of geological events as they create diatomaceous earth models of river systems.





REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	A-
Pedagogy	A-
Teacher Usability	B+
Water Resources	B

COMMENTS

General Content

"A good unit on physical river formation." "Good suplemememental unit for an earth science class." "I haven't seen anything quite like this!"

Pedagogy

"Offers a wide variety of activities." "Very concrete,'earthy' development of erosion features." "Would help to draw connections to students' lives, citizenship, and respect for the environment."

Teacher Usability

"Inexpensive, easily obtained materials are required." "Lots of teacher preparation (and basic knowledge of geology) is needed." "Easy to follow with lots of model building using the same materials throughout."

Specific Content on Water Resources

"Addresses thoroughly geologic river formation."

Session 4 : The Life and Times of Your River

Introduction

In this session your students combine the practical experience they gained in the first two sessions with the geological information from the third session to observe their rivers in a more organized way. The teams make two river runs (one five minutes, the other ten minutes) and then discuss their observations. Depending on your time constraints and the ability of your students to work in coordinated fashion, you may wish to save the discussion for another session.

Through the placement of the river features flags, students are encouraged to determine the precise sequence of events in their rivers and to use appropriate terminology. As students record their observations of events in the order in which they appear, they may come to the conclusion that many events in the life of a river cannot take place until after other events have already occurred. This helps them draw some more general conclusions about features formed by a "younger" river as opposed to an "older" one.

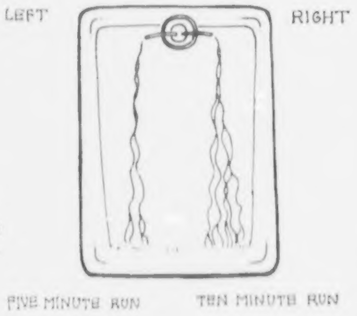
The need for teamwork and careful observation in this session also provides your students with additional practice in running their river models and creating river features, important for conducting any of the various optional sessions (Sessions 5, 6, 7).

Again, it is important to keep circulating to the various groups, making sure that the diatomaceous earth, the river model, and the drip rate are all as described in Session 1, and all students are participating in the process of recording events, planting flags, and timing the river run.

Setting the Scene

1. Tell your students that in this session they will be cutting two rivers: one for five minutes, and one for ten minutes, both with the tubs in a level position. Explain that one of the purposes for conducting the two runs is to observe what differences there may be between younger and older rivers. Add that the order in which events take place may also be different, so they should keep track.

2. Explain that the five-minute run should be made on the left side of the tub, and the ten-minute run on the right side (as seen when standing at the bottom of the slope). As features occur, students should place an appropriately-labeled feature flag at the location of the event and they should also list the event on their data sheets.



3. Ask the students, "What predictions can you make about how the two rivers might differ from each other?" You may want to note responses on the chalkboard for later reference.

4. Remind your students not to put their hands in the earth, or in any other ways interfere with the river-cutting process, and to keep the flow rate constant.

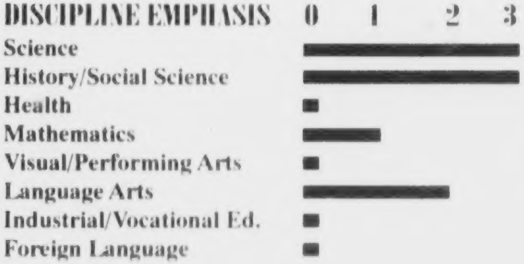
5. Have each team select a timekeeper, who should have, or be able to see, a watch or clock with a second hand. A second student should be appointed to the job of water watcher to make sure that the dripper system has an adequate water level. Others can make additional flags as needed.

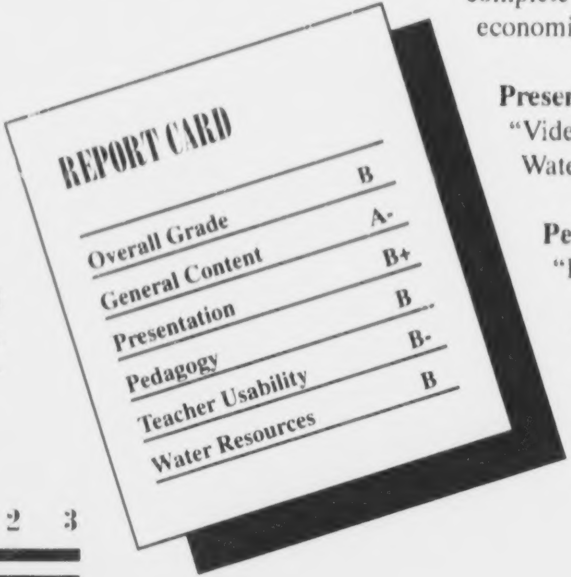
H20 - 2010

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

$25.00. 1995. Package format.

"H2O-2010" focuses on current and historic water issues in California. The six lesson plans offered in the Teacher's Guide (18 pages) examine water use conflicts; the geography of California water; water use in agriculture, business, and industry; water quality; conservation; and groundwater rights. Materials include the "H2O-2010" video and the California Water Map.





REPORT CARD

Overall Grade	B
General Content	A-
Presentation	B+
Pedagogy	B
Teacher Usability	B-
Water Resources	B

COMMENTS

General Content
"A mini-course on water use and water issues in California with a complete resource guide. It integrates environmental science, economics, earth science, and government."

Presentation
"Video offers good general information." The California Water Map is provided.

Pedagogy
"Lacks hands-on activities ... "

Teacher Usability
"Teacher needs a lot of background information to implement this."

Specific Content on Water Resources
"Valuable information on California water issues."
"Video documents the history and solutions for California water problems."

3.41

3.45

ACTIVITY 4

Water Use-
Don't be a Drip!

Objectives:

Students will:

- learn how to read a home water meter
- calculate their home use rate, per person per day
- extrapolate use rate for a year and calculate cost
- devise a home water conservation plan
- calculate the amount of water used by the class

Teacher Instructions:

DAY #1

Introductory discussion

- Before class, duplicate information sheets: "How to read your water meter" and "Daily Water Budget."
- Ask students how they use water. (Drinking, bathing, washing clothes and dishes, watering yard.)
- Ask students to guess how much water they use per day. Write estimates on board. Have students vote on most likely estimate.
- Hand out sheet: "How to read your water meter." Discuss procedure. (Note: some water districts have public information employees who will come to your classroom with a meter model and demonstrate how to read it.) Determine what the cost per cubic foot is in your area.

Assignment

Have students read their home meters and use the formula on their handout to calculate the number of gallons per person per day used in their home.

Have students also calculate the total cost of water for their household over the course of one year.

If student does not have access to a meter, make a drawing of a meter reading 118,790 cubic feet. Indicate that the last reading, made 60 days ago, was 114,330.

DAY #2

Review Assignment

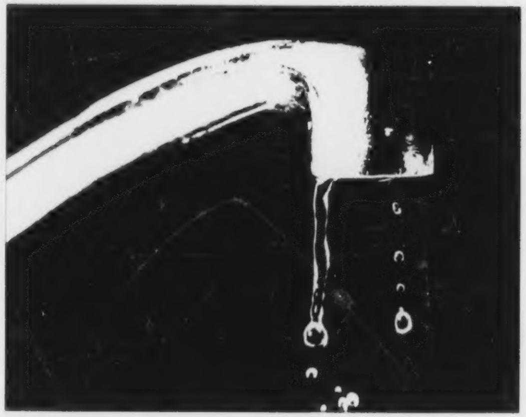
Have students list their gallons of water used per person per day on the board as they enter the class. Determine the range of values, total class water use, and an average water use rate.

Introductory discussion

- Hand out sheet entitled "Daily Water Budget" and ask students to decide which area is their household's biggest water user.
- Ask students to design a water conservation plan to save water and money.

Assignment

Each student should estimate how many gallons a day they could save by using the water conservation plan and the amount of money saved over the course of one year.

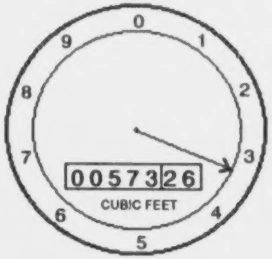


HOW TO READ YOUR WATER METER

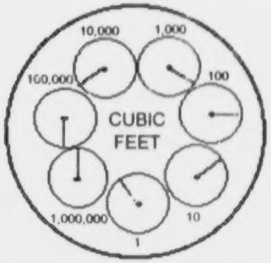
Most California communities require meters for residential and commercial customers.

Meters are usually encased in a concrete or plastic box and are located by the front curb in a direct line from the outside main faucet or valve. Water is measured in cubic feet and is either reported on a water bill in cubic feet, or in units of a hundred cubic feet, or HCF. One cubic foot equals 7.48 gallons (one HCF equals 748 gallons). Pictured below are two standard types of meters.

Straight-reading Meter



Round-reading Meter



The simplest meter to read is the one on the left, called a straight-reading meter, which is similar to the odometer on your car. Read all the digits shown but the last two. (One sweep of the dial equals one cubic foot.) The meter reading is 573 HCF.

The meter on the right, called a round-reading meter, has small, individual dials for multiple units of 10 cubic feet. Begin reading at the highest number dial and disregard the dials below 1,000. If the hand points between two numbers, use the smaller number. This meter also reads 573 HCF.

Look at your last water bill and find your previous reading (meters are normally read every two months), which will be listed as "current reading" on the bill. Subtract that amount from 573 and you'll have your water consumption since the date of the last reading.

To compute the number of gallons used per person, per day in your home, use the following equation. (Substitute 7.48 for 748 if your water is reported in cubic feet rather than HCFs.)

573 HCF (current reading)
− 559 HCF (previous reading)

= 14 HCF (consumption)

14 HCF (consumption) x 748 (gallons per HCF) = 10,472 (gallons used)

10,472 ÷ 18 (days since last reading) = 581 (gallons per day per household)

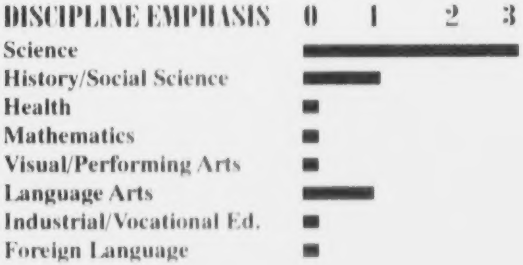
581 ÷ 4 (no. of residents) = 145 gallons per person, per day

Water, Stones, and Fossil Bones

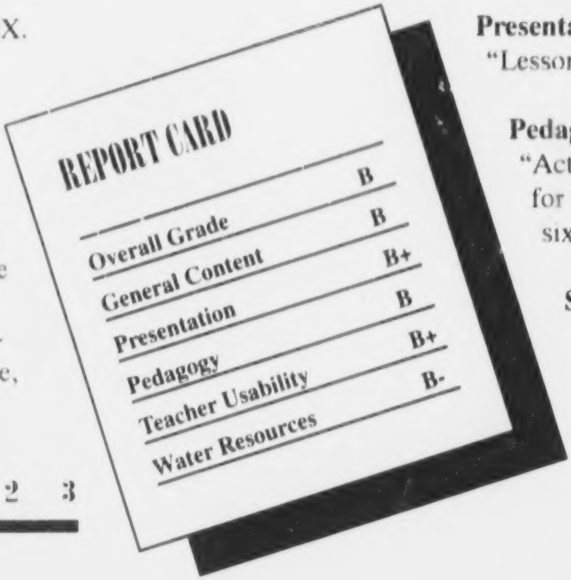
National Science Teachers Association
1840 Wilson Boulevard
Arlington, Virginia 22201-3000
(800) 722-6782

$18.50. 1991. 140 pages. Item PB089X.

"Water, Stones, and Fossil Bones" is designed to integrate earth science concepts into the teaching of elementary and middle school science. Activities begin with a focus on a particular concept and a challenge in the form of a question or problem. Hands-on procedures and further challenges enable students to explore space, land, water, air, and the earth's past.



🌧 🌧 🌧



REPORT CARD

Overall Grade	B
General Content	B
Presentation	B+
Pedagogy	B
Teacher Usability	B+
Water Resources	B-

COMMENTS

General Content
"This contains a wide variety of earth science activities."

Presentation
"Lesson format is well done." "An appealing layout."

Pedagogy
"Activities offer limited information and limited opportunity for hands-on." "Not appropriate for grades higher than sixth."

Specific Content on Water Resources
"Limited water resources scope." "Primarily earth science: geologic water properties such as filtration, leaching, erosion."

22 River Boxes

BY DAVID R. STRONCK

Focus:

Students know that rivers and streams can be muddy, especially newly formed ones. But they may not know that some of the clay, sand, and sediment that makes the river muddy comes from the riverbed itself, and is a result of the river eroding or cutting the riverbed. This activity will help students understand the erosion process and its part in the formation of rivers and streams.

Materials and Equipment:

Each group of two or more students will need:

A 1.9-L milk carton

A 2-L bottle

An outdoor source of soil (ideally a sandy soil)

A graduated cylinder or metric beaker

A metric ruler

Scissors

A water supply

A garden trowel

Challenge:

Can you build your own model of a river and show how water can cut a riverbed?

Time: 50 minutes

Procedure:

1. Begin a discussion about rivers and streams.

2. Provide each team with an empty half-gallon milk carton. Use scissors to cut out the side panel of the carton under the spout, leaving the spout intact. For younger students, you may prefer to do this cutting for them and then distribute the cartons to the groups. (If water is not available near the outdoor site for the activity, you will have to provide containers to carry water from the classroom sink.)

Q How does water move sediment and soil? How does water shape riverbeds?

3. Proceed outdoors. Lay the milk carton on its side, with the cut out panel facing up, and then dig enough soil to fill the container at least half full. Gently pat the soil to smooth the surface.

4. To simulate a flowing river, set one end of the milk carton approximately 1 cm higher than the other end, maybe using a small rock or piece of wood to prop up the carton. The lower end of the carton should be the end with the open spout so when water is poured in at the top end, it will flow over the surface of the soil and out the lower end without forming a "lake."

Q What was the water carrying down the river? Where did the sediment come from? How did the water cut a riverbed?

5. Place the mouth of the bottle on the edge of the higher end of the carton, and slowly pour 2 L of water on the soil, maintaining an even, constant flow of water (see the figure). The goal is to provide a small stream of water, not a sudden flood. Observe what happens to the water and the characteristics of the resulting river, including the path cut and the depth of the riverbed.

If the soil is dry, much of the water will simply be absorbed into the soil, but do not use more than 2 L of water. Runoff of the water in a surface stream will not begin until the soil is soaked with water.

6. Now, repeat steps 3 through 5 with a fresh soil sample, but raise the end of the carton to 3 cm. Be sure to use the same amount of water as in the first trial. Observe the difference in the flow of the water and the resulting river compared to the previous trial.

7. Repeat the procedure for a third time, raising the carton to a height of 5 cm. Compare the flow of water and the river cut to those of the other two trials.

Q As the slope of the carton was increased, what happened to the depth of the river formed?

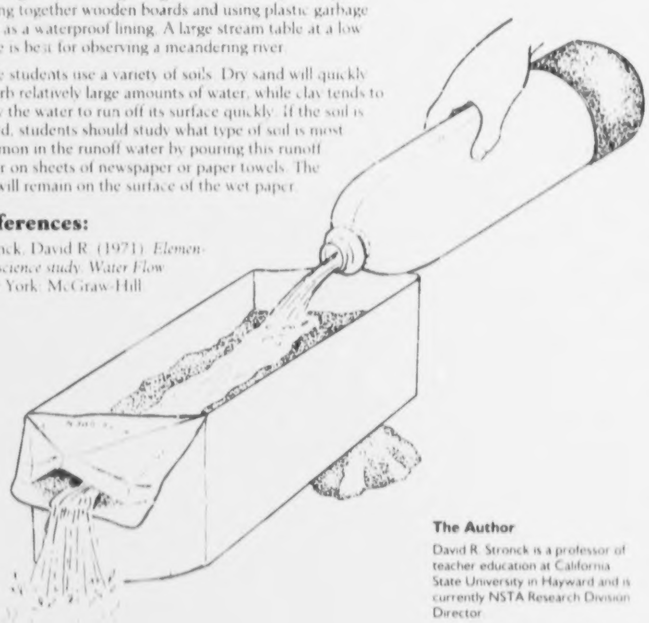
Further Challenges:

You might try building a large stream table by sawing and nailing together wooden boards and using plastic garbage bags as a waterproof lining. A large stream table at a low angle is best for observing a meandering river.

Have students use a variety of soils. Dry sand will quickly absorb relatively large amounts of water, while clay tends to allow the water to run off its surface quickly. If the soil is mixed, students should study what type of soil is most common in the runoff water by pouring this runoff water on sheets of newspaper or paper towels. The soil will remain on the surface of the wet paper.

References:

Stronck, David R. (1971). *Elementary science study: Water Flow.* New York: McGraw-Hill.



The Author

David R. Stronck is a professor of teacher education at California State University in Hayward and is currently NSTA Research Division Director.

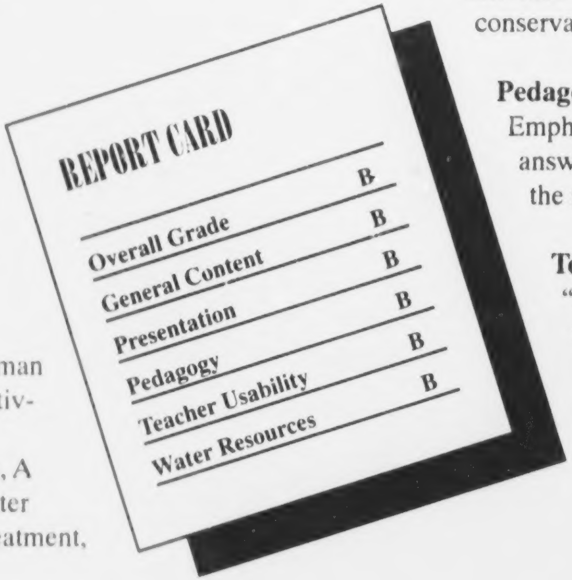
Hands-On Environmental Science Activities

Alpha Publishing Company, Inc.
1910 Hidden Point Road
P.O. Box 6636
Annapolis, Maryland 21401
(410) 757-5404

🌧 🌧 🌧

$45.00. 1992. 260 pages.

The Teacher's Edition, together with the Laboratory Manual for "Hands-On Environmental Science Activities," offer enrichment activities in environmental science. Eight units present forty activities in the following areas: ecology, energy, conservation of Earth's resources, human and animal populations, pollution, activism, politics, and economics. Water activities include Water Consumption, A Case Study: the Ogallala Aquifer, Water Pollution and Water Plants, Water Treatment, and Oil Spills.



REPORT CARD

Overall Grade	B
General Content	B
Presentation	B
Pedagogy	B
Teacher Usability	B
Water Resources	B

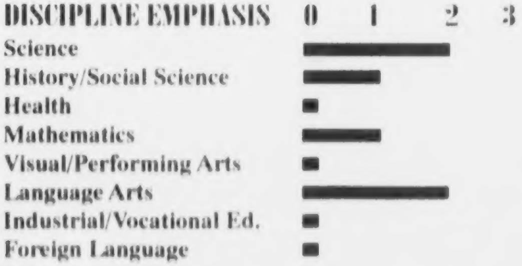
COMMENTS

General Content
"A good environmental science book." "A collection of interesting activities done with easily obtainable materials." Focuses on water conservation, acid rain, water treatment, and oil spills.

Pedagogy
Emphasis is placed on thinking and process skills. "Some answers are biased - not open to opinion differences," such as the response given to questions on Ogallala water use.

Teacher Usability
"Hands-on, lab-type experiments would be good for a teacher who can set up a lab."

Specific Content on Water Resources
One section is devoted to water issues.



WATER POLLUTION AND WATER PLANTS

INTRODUCTION: Water **pollution** affects everyone. It damages life in rivers, lakes and oceans. It affects our health. So why do we still have it? For one thing, the waste products of industry are not that easily controlled. Many of them are **toxic**, and are difficult to find and remove. For another, although many pollution sources come from a small area, such as a factory, many do not. These non-point sources include chemicals and pesticides washed into the water supply from large farm areas. Because they are so spread out, they are difficult to control. In this activity, you will investigate the effects of some water pollutants on water plants. Perhaps in the future, you will discover a way to reduce the water pollution problem.

PURPOSE:

- What are some effects of water pollution?

MATERIALS:

7 jars with lids
marking pencil
aquarium or pond water
duckweed, or elodea or other water plants
teaspoon
lawn fertilizer
powder, phosphate based detergent
powder, non-phosphate detergent
liquid detergent
liquid soap
motor oil
goggles
lab apron

PROCEDURE: **Put on goggles and a lab apron.**

1. Get 7 jars. Fill each to the same level, about three-quarters full, with aquarium water. Number the jars from 1 to 7.
2. As shown in the illustration, place two duckweed fronds (these look like leaves) or two equal length sprigs of elodea into each jar.
3. The first jar is the control. Add nothing more to it.

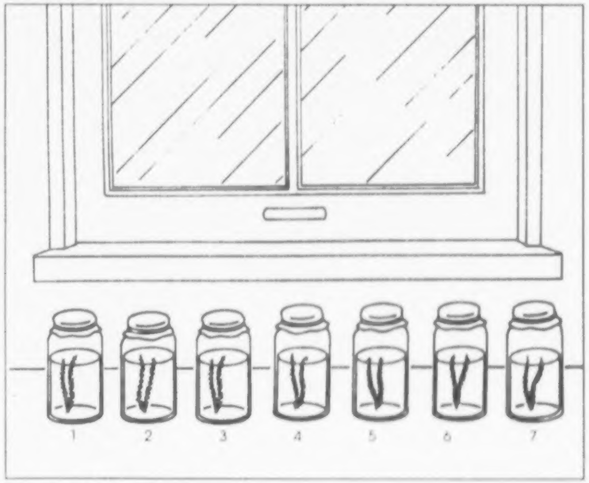


Illustration 18-1. *Testing the effects of water polution*

Add 1/4 teaspoon of lawn fertilizer to jar 2.

Add 1/4 teaspoon of phosphate powder detergent to jar 3.

Add 1/4 teaspoon of non-phosphate powder detergent to jar 4.

Add 1/4 teaspoon of liquid detergent to jar 5.

Add 1/4 teaspoon of liquid soap to jar 6.

Add 1/4 teaspoon of motor oil to jar 7.

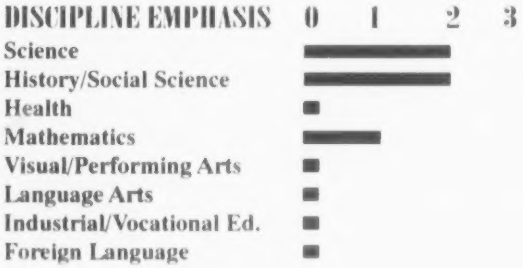
4. Cover each jar and shake it for 30 seconds. Place all of the jars in good light. Observe them every day for a week. Add another dose of the proper chemical to each jar and observe for another week. Record your observations.

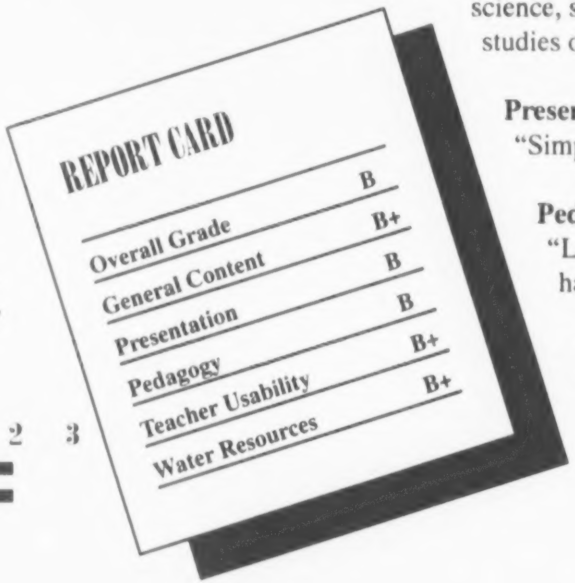
Water Watchers

Massachusetts Water Resources Authority
100 First Avenue
Boston, Massachusetts 02129
(617) 241-4643

No charge. 1983. 43 pages.

"Water Watchers" is designed for seventh and eighth grade science and social studies. The Teacher's Guide includes a series of activities based upon five core water conservation themes. Optional activities, additional resources, and a bibliography are also provided.





REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B
Teacher Usability	B+
Water Resources	B+

COMMENTS

General Content
"Good source of information for students." "A good balance of science, social science, and mathematics." Offers interesting case studies of town development and water supply.

Presentation
"Simple ditto masters." "Some good diagrams."

Pedagogy
"Lacks assessment." "Needs less worksheets and more hands-on inquiry."

Teacher Usability
Recommended support materials are available through Massachusetts Water Resources Authority.

Specific Content on Water Resources
"Deals primarily with water conservation issues." Some information is specific to the Boston region.

356

357

Master #2

Name______________________________

Date_______________________________

HOME WATER USE INVENTORY

Number of water users in your household_______

PLEASE POST IN BATHROOM

Directions: Put a checkmark in the proper column each time that any of the following activities is performed.

Activity	Gallons per use	Tuesday	Wednesday	Total Uses	Total Gallons
Toilet Flush	5				
Tub bath	36				
Shower	25				
Teeth brushing					
(Water running)	5				
(Water not running)	1/2				

PLEASE POST IN KITCHEN

Directions: Put a checkmark in the proper column each time that any of the following activities is performed.

Activity	Gallons per use	Tuesday	Wednesday	Total Uses	Total Gallons
Hand washing dishes					
(with water running)	30				
(in basin)	10				
Dishwasher use	20				
Clothes washer use	30				
Meal preparation	5				

AQUIFER DEMONSTRATION

Use the following supplies from the science kit to demonstrate water movement in an aquifer.

- pebbles
- plastic box
- food coloring
- spray bottle

Put pebbles into the plastic box, making a low pile towards one end which slopes toward the middle. Add enough water to wet the pile and cover the other end of the tray. Drip a little food coloring onto the pile. Spray water onto the pile. Have students observe how currents carry colored water through the layer of pebbles and into open water.

5. Distribute copies of the "Water Cycle" worksheet (Master #1). Based on what you have read in the Background Information, help students determine where the runoff in the watershed goes. Explain the vocabulary and have students label the diagrams for reference during the unit. Have them write brief definitions of the words on their worksheets.

6. Important Homework Assignment: Pass out the "Home Water Use Inventory" worksheets (Master #2), and ask students to keep track of how often each activity listed happens in their homes for the next two days. Tell them to be sure to include everybody who uses water at the house. Go over the water usage information and data collection procedures with them. Stress that they will need the data they collect for Lesson IV.

WORKSHEET ANSWERS

Master #1: The Water Cycle

a. Evaporation is the process of water becoming a vapor.

b. Condensation is the process of water vapor becoming a liquid.

c. Precipitation is rain, hail, sleet and snow.

d. Runoff is water travelling over Earth's surface.

e. Groundwater is water that collects between particles of sand and gravel under Earth's surface.

f. An aquifer is the area of sand and gravel where groundwater collects and flows.

g. Transpiration is the loss of water vapor from the surface of leaves.

h. A dam is a structure to hold back runoff.

i. Reservoir is the body of water that collects behind a dam.

j. A well is a structure that taps into groundwater for a water supply.

Master #2: Home Water Use Inventory

Individual data will vary.

LESSON I EXTENSION: Questions for Further Exploration

What watershed is your community in? Is it in more than one watershed? Do you live in one watershed and go to school in another? Are there wetlands in your community? Where are they in relation to ponds or streams? Have wetlands that once existed in your area been filled for development? How might this affect water supply?

For answers to these questions, use a USGS* map of the quadrant(s) for your area. Follow elevation lines to find watershed boundaries. Use the marsh symbol to identify wetland areas. Check old town and city maps and local history to learn about development.

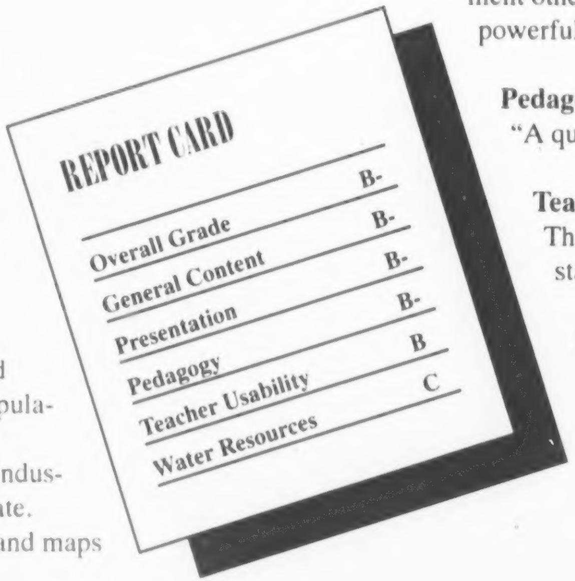
*United States Geodetic Survey map. Refer to Resource section at back of guide for sources.

The Geography of Water

Metropolitan Water District of Southern California
Education Programs
P.O. Box 54153
Los Angeles, California 90054-0153
(213) 217-6398

$5.00. Materials are free in MWD Southern California service area. 1989. Folder format.

"The Geography of Water" offers a collection of lesson plans that focus primarily on the physical aspects of water distribution in California, namely physical features, elevation, and precipitation. Water is examined within the context of California's population, distribution of rivers and water supply systems, and the residential, industrial, and agricultural needs of the state. Forty-four reproducible worksheets and maps accompany six teacher booklets.



REPORT CARD

Overall Grade	B-
General Content	B-
Presentation	B-
Pedagogy	B-
Teacher Usability	B
Water Resources	C

COMMENTS

General Content

"Covers geography, which is sorely neglected, and would supplement other curricula with geographical literacy." "Simple, yet powerful presentation on the status of water in California."

Pedagogy

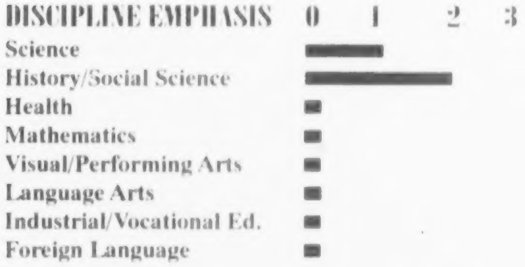
"A question and answer approach."

Teacher Usability

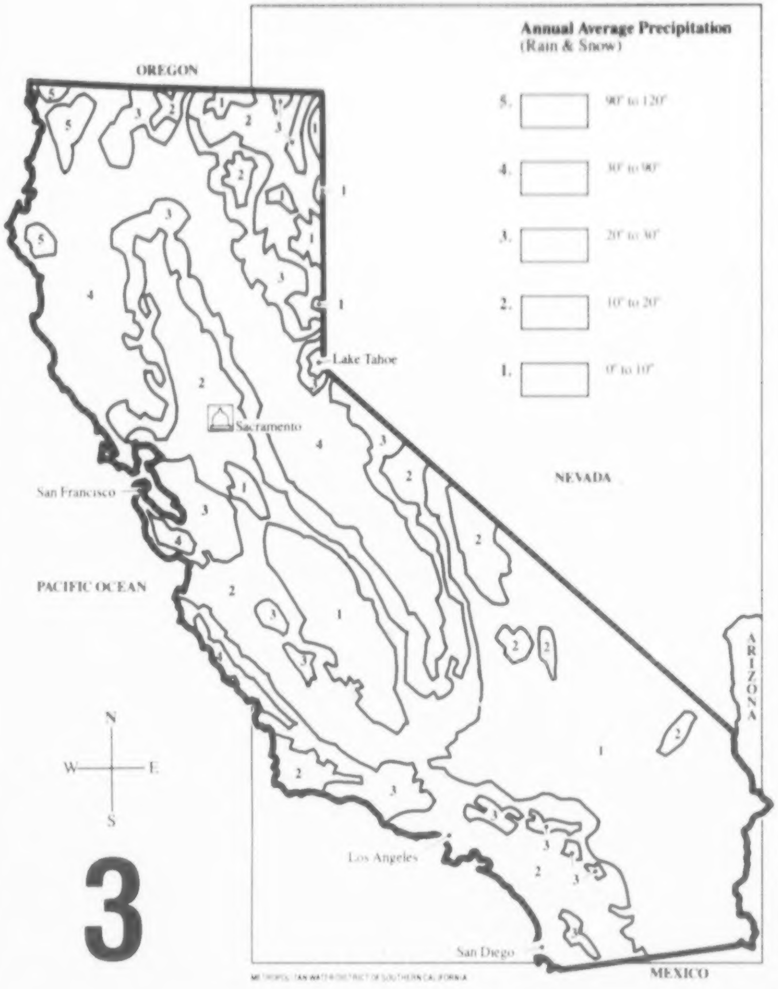
This is not a curriculum, but it does offer map resources and state statistical data.

Specific Content on Water Resources

Covers water problems and distribution in California.



PRECIPITATION



3

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

PRECIPITATION/Teacher Guide

General Objectives

1. **The student will gain an understanding of the distribution of** precipitation throughout the state of California and will be able to distinguish the "wet" and "dry" areas.

2. By comparing Map #3 with Map #1, the student will understand the relationship between elevation and precipitation.

3. By comparing Map #3 with Map #2, the student will understand which of California's major physical features (mountains, valleys, deserts) receive higher or lower levels of precipitation.

4. The student will gain a clear understanding of the different levels of precipitation which occur in Northern and Southern California.

Vocabulary

Before beginning study of Map #3, you may wish to introduce the following vocabulary:

aqueduct
border
fresh water (water suitable for drinking; not salty)
irrigation
legend (map)
range (mountain)
symbol for "inches" (")
valley(s)

Guided Questions

Note: These questions are intended for discussion and hypothesizing as a way to get the students thinking about the map before they begin the actual study.

Look at your unfinished map. Since you have already studied elevations and physical features in California, where do you think most of the precipitation in California takes place?

Answer: At the higher elevations which are mostly located in Northern California. The high mountains receive more precipitation in the form of snow and often also receive more rainfall.

Based on what you have learned from maps #1 and #2, where do think California's driest areas (areas with least precipitation) are located?

Answer: In southeastern California. This is where the Mojave Desert is located (Map #2, item 25d) and this is where the fewest high mountains are found.

1

3

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

GRADES 7-9

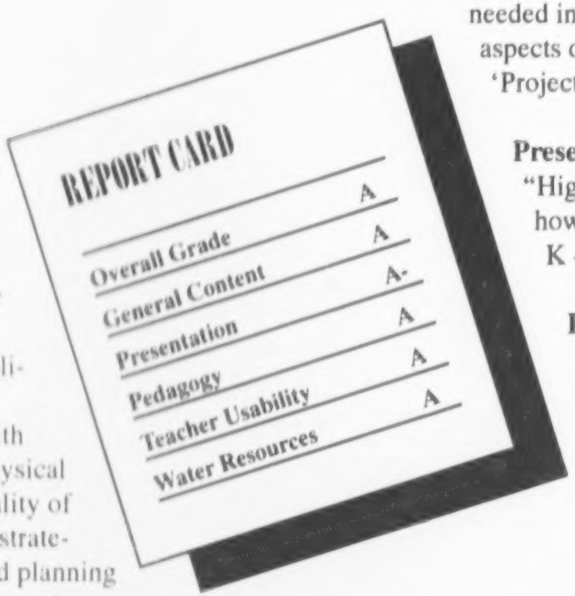
BEST COPY AVAILABLE

Project WET Curriculum and Activity Guide

The Watercourse and Council for
Environmental Education
c/o Montana State University
201 Culbertson Hall
Bozeman, Montana 59717-0570
(406) 994-5392

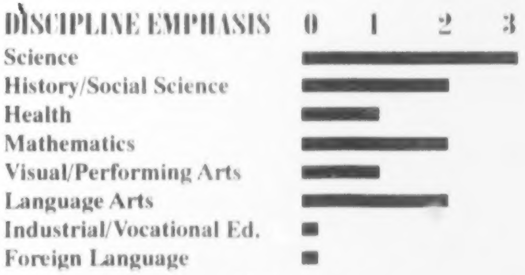
Only available through training workshop. 1995. 516 pages.

Project WET is a national water education program designed to promote awareness, appreciation, knowledge, and stewardship of water resources. This guide reflects these goals in a collection of 91 interdisciplinary activities for K - 12. Content focuses on the human relationship with water, as well as the chemical and physical properties of water, quantity and quality of water, ecosystems, and management strategies. Extensive cross-referencing and planning charts, a supplemental resource guide, and a glossary are provided.



REPORT CARD

Overall Grade	A
General Content	A
Presentation	A-
Pedagogy	A
Teacher Usability	A
Water Resources	A



COMMENTS

General Content

"Outstanding freshwater education program." "Has everything needed in one place." "A comprehensive program dealing with all aspects of water." "Is the water equivalent of 'Project WILD' and 'Project Learning Tree.'"

Presentation

"Highly organized." "The K - 12 option is great. It shows how to take a lesson labelled 4 - 8 and use it effectively in a K - 2 class."

Pedagogy

"Some activities are open-ended in which students create an investigation using lab techniques - great!" "Well documented and [thoroughly] developed for use by teachers." "Offers authentic assessment strategies." Appears more geared toward middle and elementary levels.

Teacher Usability

"Very easy to use." "Complete with background information."

Specific Content on Water Resources

All inclusive.

The Price Is Right

■ Grade Level:
High School

■ Subject Areas:
Mathematics (Economics), Government, Environmental Science

■ Duration:
Preparation time: 30 minutes

Activity time: 50 minutes

■ Setting: Classroom

■ Skills:
Gathering information (calculating, measuring); Analyzing (comparing and contrasting); Evaluating; Presenting

■ Charting the Course
Students should conduct "Wet-Work Shuffle" prior to this activity to understand water treatment systems. These systems are further explored in "Reaching Your Limits" and "Sparkling Water." Other water management projects that require consideration of costs and benefits are found in "Humpty Dumpty," "Super Bowl Surge," and "Dilemma Derby."

■ Vocabulary
easement, municipal water system, well field

When you pay your water bill, what exactly are you paying for?

Objectives

Students will:

- calculate the costs involved in supplying clean water to consumers and removing wastewater.
- recognize that cost and environmental considerations influence the planning and construction of water projects.

Materials

- *Sample water bill* (optional)
- *Copies of* ***Student Data and Instruction Sheet***
- *Copies of* ***Water Development System Map***
- *Calculators*
- *Ruler*

Making Connections

Students who earn their own spending money likely understand the value of certain things, such as compact disks, snack foods, or gas for their cars. They have probably heard adults complain about paying bills, such as the water bill. They may wonder why we pay for water. Learning the real and sometimes hidden costs and processes involved in supplying clean water to and removing wastewater from homes helps students appreciate the value of water resources.

Background

Individuals, businesses, communities, states, and countries are all involved in water resource economics on a daily basis. The cost of water influences individual and community decisions, such as whether to take long showers, whether to purchase a new water-efficient irrigation system, and whether to upgrade a wastewater plant.

When current water supplies no longer meet the needs of a growing community or when the waste generated by this growing population becomes too much for a treatment plant to process, water management decisions must be made. Options include reducing water consumption through conservation, installing more efficient water technologies, and building new treatment facilities. People may be asked to approve an increase in taxes or an increase in water or wastewater treatment bills to cover additional costs. Whatever option is chosen, chances are public funds will be needed; therefore, citizens will have opportunities to voice their opinions and to raise concerns. Most levels of government conduct public planning forums.

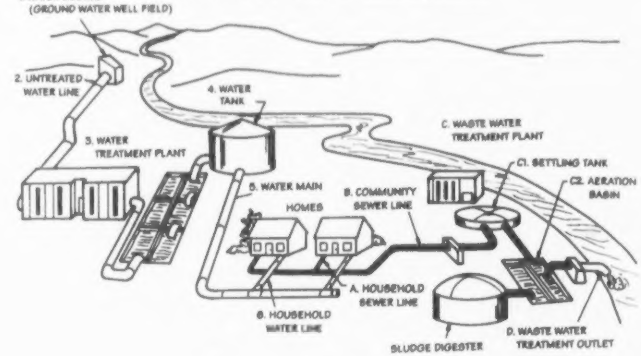
There is far more to constructing a water project than meets the eye. Aside from the construction of the physical plant, surveying potential sites, engineering water lines, establishing operation systems, and maintaining production also contribute to the cost. The list in the side bar on page 335 highlights costs associated with various water projects. (Costs vary among different regions of the country.)

Procedure

▼ *Warm Up*

Show or describe a water bill to students. What do they think is involved in establishing the cost of water? Why does water need to be paid for? To help students appreciate the costs involved in securing water resources, have students play a price guessing game. Using the list of sample costs on page 335, ask them to guess the cost of a particular project. Instruct them to guess "higher" or "lower" until they reach the correct price.

Components of Municipal Water and Wastewater Treatment Systems



ADAPTED FROM "A WATER SYSTEM" (POSTER), BY PERMISSION. © 1988, AMERICAN WATER WORKS ASSOCIATION.

Ask students to diagram how they think water gets from a water source to their homes, and from their homes back to the water source. Review the *Components of Municipal Water and Wastewater Treatment Systems* with students. What do students think of the costs reflected in a water bill now?

▼ *The Activity*

1. **Explain to students that their task is to help a community redesign their municipal water and wastewater treatment systems.** A new water treatment plant has already been built, but they need to construct water lines through which untreated water can flow from the source (a ground water well field) to the new plant. In addition, a new wastewater treatment plant must be built and sewer lines run from the community to the plant. Both construction projects need to use Best Management Practices; "best" can be defined as the route and location that require the least costs and have fewer environmental effects. NOTE: Real-life situations would involve many other considerations for choosing the best location, including health concerns, substrate conditions, aesthetics, political matters, and so forth.

2. **Divide the class into small groups; supply each group with a copy of the *Water Development System Map* and review its contents and environmental features. Give each group a copy of the *Student Data and Instruction Sheet* and discuss.**

3. **Allow time for groups to identify what they think is the best location for each project.**

▼ *Wrap Up*

Have each group present its proposed plan and calculated costs for class review. Group members should summarize considerations and factors they used to help them make the decision. Encourage students to provide constructive criticism for the proposed plans. Can the class reach consensus regarding where to locate the projects?

Present students with the *Answer Key*. Do students agree with the solutions given in the key? Tell students that if this was a real-life situation, other factors and conditions would come into play, and the actual locations might be different. In other words, students may have justifiable reasons why their proposals are better.

Inform students that in some situations, citizens must pay additional taxes to fund the construction of water management projects. How do

©The Watercourse and Western Regional Environmental Education Council (WREEC)

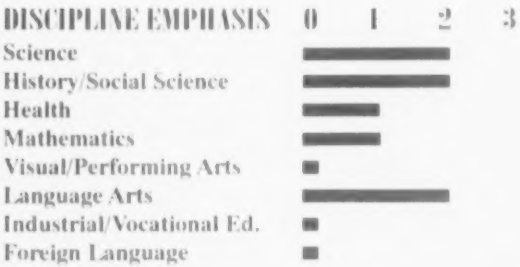
San Diego: World in Harmony

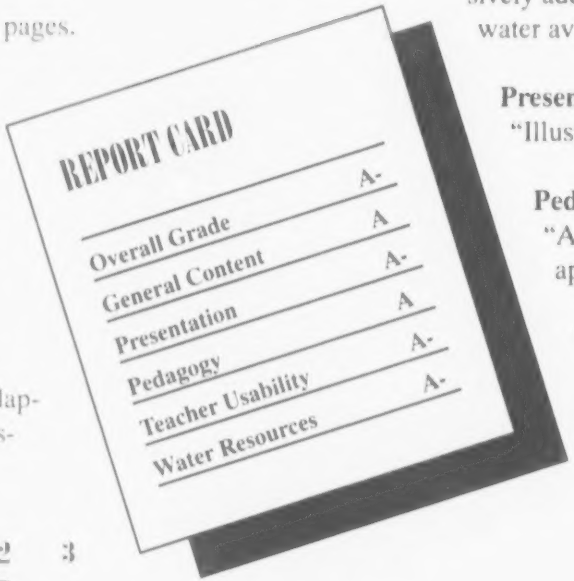
I Love a Clean San Diego County, Inc.
7907 Ostrow Street, Suite F
San Diego, California 92111
(619) 467-0103

🌧 🌧 🌧 🌧

$20.00 (includes shipping). 1994. 496 pages.

Issues surrounding waste disposal, waste reduction, and resource recovery are explored through numerous interdisciplinary activities. Five of fifteen units specifically address water issues, including polluted urban runoff, sewage, water conservation, and water reclamation. Extensive background information, extended challenges, recommended adaptations for special education, and cross-referencing by subject are provided.





REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	A
Teacher Usability	A-
Water Resources	A-

COMMENTS

General Content

A comprehensive look at regional environmental issues. "Extensively addresses areas of societal concern and impact regarding water availability and use."

Presentation

"Illustrations reflect cultural diversity." "Needs an index!"

Pedagogy

"A cross-curricular package." "A thematic, interdisciplinary approach."

Teacher Usability

"Requires a basic knowledge of chemistry, physics, and geology of water." Includes enrichment activities and suggested modifications for students with special needs. "Offers excellent background information."

Specific Content on Water Resources

Excellent coverage of San Diego and Southern California water resource issues. "Effectively addresses controversial water issues, such as regional control of water resources."

Introduction

Determining an Effective Level of Chlorination

An effective way to kill microorganisms in water is to add chlorine. But chlorine can be harmful to humans if the concentration is too high. So when treating water with chlorine, it is important to determine the lowest concentration needed to prevent biological contamination. In this lab, you will experiment with green algae, a harmless microorganism.

Challenge

Determine the lowest concentration of chlorine in ppm that kills green algae.

Materials

For each group of four students:

- One 30-mL dropping bottle of household (5.25%) bleach solution
- One plastic cup filled with about 100 mL of green algae water

For each pair of students:

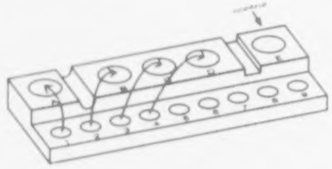
- One SEPUP tray
- One 30-mL dropping bottle of distilled water
- One 50-mL graduated cylinder
- One dropper
- One plastic cup half filled with tap water for rinsing
- One piece of white paper
- One paper towel

Procedure

Safety

Do not bring chemicals into contact with your eyes or mouth. Wear safety eyewear as directed by your teacher. Avoid getting bleach on your clothing.

1. Set up your investigation report. Prepare a data table like the one on the next page.
2. With your partner, make a four-step serial dilution of the household (5.25%) bleach solution. This solution contains 13,000 ppm chlorine. Begin by putting 10 drops of the chlorine bleach into Cup 1 of the SEPUP tray. Move one drop to Cup 2 and dilute it with 9 drops of the distilled water. Repeat this process until you get to Cup 4.
3. Carefully measure and pour 5 mL of the algae water into each of the five large cups on the SEPUP tray. Be sure to record the color of the algae water when observed over a white background.
4. Treat the water in Cup A with 5 drops of the concentrated chlorine solution from Cup 1. Treat Cup B with 5 drops of the first dilution from Cup 2. Cup C should be treated with 5 drops of the chlorine dilution in Cup 3, and Cup D with 5 drops from Cup 4.



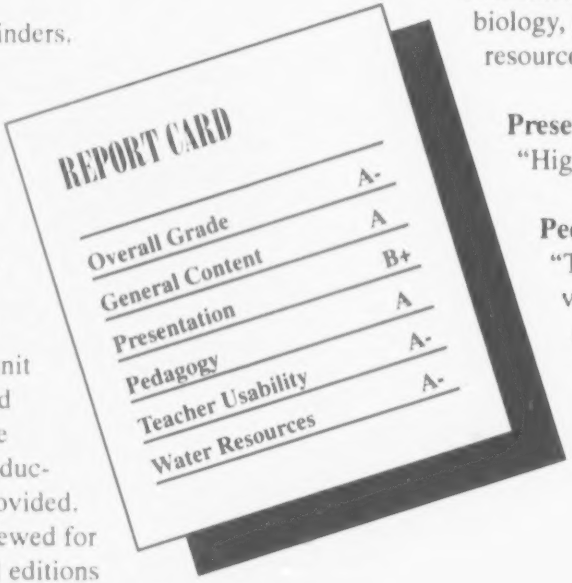
5. The algae water in Cup E is a control. Do not put any chlorine in it. Instead, put in 5 drops of the distilled water.
6. Carefully observe any color changes. Keep track of the time it takes for changes to occur.
7. Complete the Data Processing section.

Rivers Project

Rivers Project
Southern Illinois University
P.O. Box 2222
Edwardsville, Illinois 62026-2222
(618) 692-3788

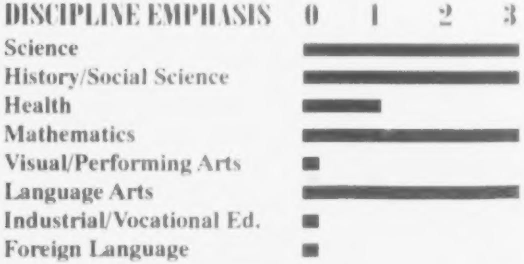
$12.00 per binder (draft). 1996. Six binders.

The "Rivers Project" introduces students to aquatic ecosystems through a multidisciplinary approach involving geography, biology, mathematics, chemistry, language arts, and earth sciences. All six units are intended to be used simultaneously for an in-depth study of local waterways, although each individual unit can stand alone. Student portfolios and extensive laboratory and field work are incorporated into the activities. Reproducible worksheets and appendices are provided. Draft editions of the binders were reviewed for the purpose of the compendium. Final editions will be available commercially through Dale Seymour Publications.



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	B+
Pedagogy	A
Teacher Usability	A-
Water Resources	A-



COMMENTS

General Content

"An excellent resource for an integrated project. Applies the skills of mathematics and language arts as well as concepts in chemistry, biology, geography, and earth science to a river system." "A great resource for an on-site study!"

Presentation

"Highly organized and complete."

Pedagogy

"The inclusion of a field trip provides relevance." "Provides a variety of cross-curricular activities." "Some activities may be too difficult for high school students."

Teacher Usability

"This curriculum may be used as a six part interdisciplinary program for a school cluster or each component may be used for a stand-alone subject." Lessons are very complete. "To be truly effective, cooperation among [the teachers of] all disciplines is required."

Specific Content on Water Resources

Focuses primarily on streams and rivers.

ACTIVITY FIVE:
How Do Humans Interact with the River?

FOCUS:
Human-Environmental Interaction

OVERVIEW:

The physical environment does not compel humans to use it in a predictable fashion. Because of peoples' varied cultural backgrounds and their abilities to change landscapes, a variety of human activities may be identified in very similar physical environments. The physical environment does pose some limitations and challenges to human uses, but each landscape displays unique cultural features owing to human choice. One's perception and subsequent use of the environment is tied to cultural values and personal decisions.

Human interactions with the natural river environment range from activities which are as simple as viewing the environment to those which permanently alter the river on a large scale. Decisions to modify the physical environment are based on the belief that the changes which make the environment more useful for human activities. For example, North America's St. Lawrence River and the Great Lakes were modified to permit the passage of large ships. Dredging deepened the channel to 27 feet, and 16 locks--eight of them to by-pass Niagara Falls--were constructed to overcome the 580 feet of elevation change. Now all but the largest ocean-going vessels can be accommodated.

The gradient of the Upper Mississippi River between St. Louis and Minneapolis-St. Paul, head of the commercial river navigation, was modified to more easily handle barge traffic. The construction of 26 locks and dams have reduced the river to a series of pools.

Floodplains are what the name suggest. In its natural state, a river will overflow its banks during flood stage and cover the adjacent low areas along the river with water. A floodplain's alluvial soils, however, are many times irresistible to humans who want to use them for agriculture and increasingly for the construction of factories, highways, and residences. In order to protect their investments, people have constructed artificial levees to prevent flooding of the floodplain.

Bridges, straightening of channels, artificial dikes, canals, and dams to regulate flow are other examples of purposefully changing the natural character of a river. Rivers may also be altered inadvertently, such as by the removal of vegetation and paving of the land surface (both increase runoff), accelerated erosion of soil due to poor farming practices, and the release of foreign matter into waterways.

INSTRUCTIONAL PROCEDURE:

Introducing the lesson.

1. Prior to beginning this activity, the teacher should cut out regional descriptions, role cards, and regional problems so that they may be distributed to the four groups. If the activity is to be used in more than one class, the slips should be laminated.

2. Divide the class into four groups, and arrange students in such fashion that each can be seen and heard by all others in the group. Distribute to each group a map and description of one of the four regions. Several minutes must be allowed for students to match features on the map with the written description of the region. (One student in each group may be selected to read the description aloud).

3. Distribute role cards. Impress upon students that each must "play" his/her role in the group discussion and take a stand on the problem presented to the group. In groups where there are fewer students than roles to be played, the roles not played should be read aloud. (Teaching hint: The first five roles of each region must be played (20 students). If the class contains fewer than 20 students, omit either region B or C. Additional roles are provided for more students).

Developing the lesson.

Each group is presented with a problem of land use and asked to select the best of several alternative choices. Role descriptions serve as guides to interaction. After each group has made its presentation, the teacher and other class members may question the decision.

How did your group arrive at its decision?

Whose argument was most influential? Why?

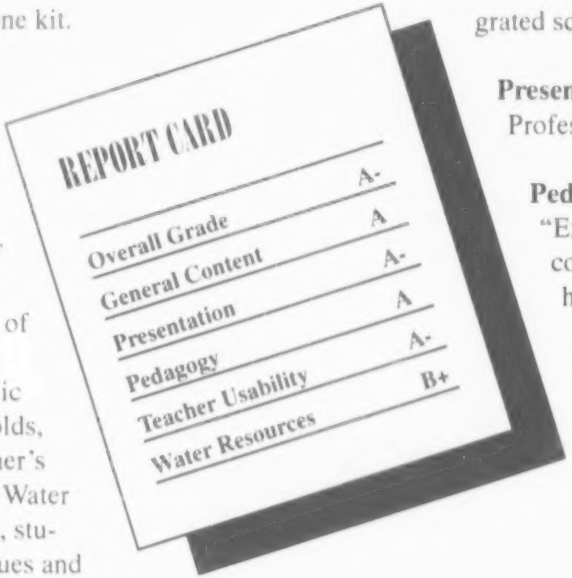
What problems may be created by your decision?

Issues, Evidence and You: Water Usage and Safety

Sargent-Welch VWR Scientific, Distributors
911 Commercial Court
Buffalo Grove, Illinois 60089
(800) 727-4368

$3,484.99 for entire package. 1995. One kit.

Created by Lawrence Hall of Science, "Issues, Evidence and You" is part of the curriculum project SEPUP (Science Education for Public Understanding Program). "Water Usage and Safety," part one of four parts, was evaluated without its laboratory component for the purpose of the compendium. The water section deals with such societal issues as public health, groundwater pollution, thresholds, risks, and toxicity. Through the Teacher's Guide (919 pages, binder format) and Water Usage and Safety booklet (157 pages), students are challenged to investigate issues and generate solutions.



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	A
Teacher Usability	A-
Water Resources	B+

COMMENTS

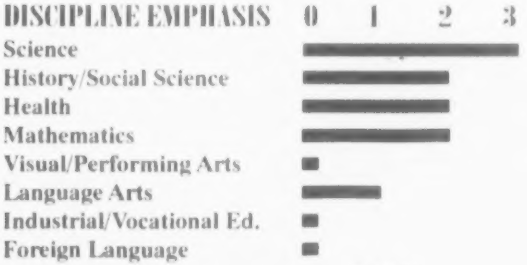
General Content
"SEPUP is a wonderful, activity-oriented curriculum." "This material uses an issue-oriented approach which is useful for an integrated science curriculum."

Presentation
Professionally-packaged materials.

Pedagogy
"Excellent presentations of labs that allow students to construct meaning from the data they interpret." "Very hands on." "All lessons involve active learning."

Teacher Usability
"Teacher directions are great!" "Teacher preparation is minimal." "Expensive to purchase."

Specific Content on Water Resources
A comprehensive overview of water issues and human health, but the conservation message is not present. "The water theme is narrowly focused with an emphasis upon chemistry."



378

377

Water
Use It Carefully
San Diego!

"The Great Water Debates!"
A Language Arts Activity

Summary:

After reading and briefly discussing maps and three segments from the "Overview for Teachers," which present a series of issues pertaining to the importation of water to Southern California from the Bay-Delta Region and the Colorado River, the students respond in writing to questions on their Student Experience Sheets. These questions solicit point-of-view statements representing the various factions in ongoing water debates and conflicts. Next, issue by issue, students volunteer to make verbal point-of-view presentations, earning one point per presentation with a five point maximum. Discussion concludes the activity.

Primary Goal:
To enable students to gain vivid perspective on all factions in the ongoing issues/conflicts regarding the importation of water to Southern California.

Content Objectives:
Students will learn that:
- Numerous complex issues are creating a major dilemma for California's exportation of water from the Bay-Delta Region. These issues concern population, flora and fauna, water availability, water transfers, and water quality.
- The Peripheral Canal proposed to California voters and rejected in 1982, is once again being suggested as one solution to some of the current problems of the Bay-Delta as a water source for Southern California. As with many other issues, Californians in the northern and southern parts of the state are strenuously divided on this issue.
- Legally, Arizona is "claiming back" on a yearly incremental basis, the 650,000 acre feet of its own annual portion of Colorado River water that California has been purchasing since 1963. This places an additional strain on our water resources.

Process Objectives:
To enable students to develop and utilize the following skills and abilities:

Framework Connections:
Reading factual material
Questioning
Utilizing oral language

CLAS Connections:
Intellectual engagement with written material
Generating questions/responses

Time Needed:
Two class sessions with sufficient intervening days for conducting research. (Allow a week or two for students to receive information in the mail if it is not present in the classroom.)

Materials/Preparations Needed:
- A copy of the following sections from the "Overview for Teachers" for each student:
  - —A Summary of Bay-Delta Issues
  - —The Possibility of a Peripheral Canal is Reintroduced
  - —Summary of Colorado River Issues
- Maps B and C
- The Student Experience Sheet: "The Great Water Debates!"
- An assortment of booklets and pamphlets from the various agencies listed in the "Resources" section, notably the San Diego County Water Authority and the Metropolitan Water District of Southern California. (As an alternative these may be obtained by the students themselves. If you select this alternative, write the names, addresses, and phone numbers for the agencies on the chalkboard or a chart for students to refer to.)

Water
Use It Carefully
San Diego!

"The Great Water Debates!"
Student Experience Sheet

Do you know about the controversies in the State of California over water, and do you know that *we* are a major reason for those controversies? Residents of San Diego County and other counties in Southern California have been able to live here because of the water we import from Northern California and the Colorado River.

Whenever there is controversy, there are at least two points of view. Every person, group, or "faction" has the right to hold a point of view. You have read about the issues and looked at some maps. Now, think about some of the serious points of view various factions hold with respect to the Bay-Delta Region and Colorado River issues. Use this experience sheet to help you clarify your thoughts.

1. Imagine that you are a representative of the Environmental Protection Agency (E.P.A.) and it is your job to speak for the many species of plants and animals who can't speak for themselves. What is your point of view?

2. Now imagine that you are a farmer. The runoff pollution from your farm, which is located at the southern portion of the Delta, is flowing into the aqueduct that takes water to Southern California. You don't know how to stop it. What is your point of view?

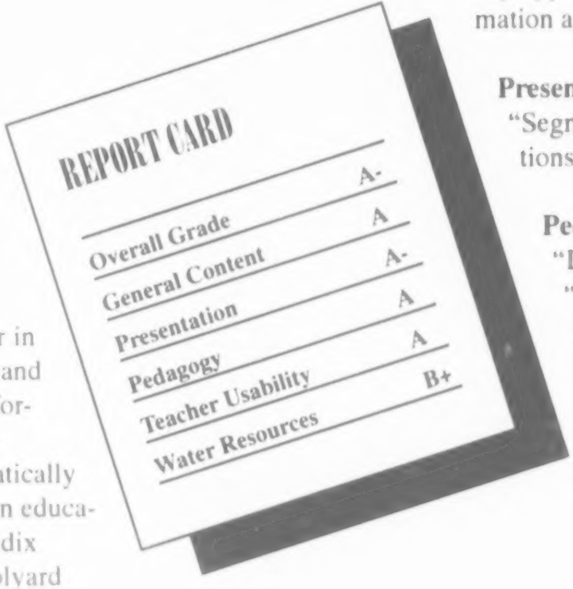
WOW! The Wonders of Wetlands

Environmental Concern, Inc., and
The Watercourse
c/o Montana State University
201 Culbertson Hall
Bozeman, Montana 59717-0570
(406) 994-5392

$15.95. 1995. 330 pages.

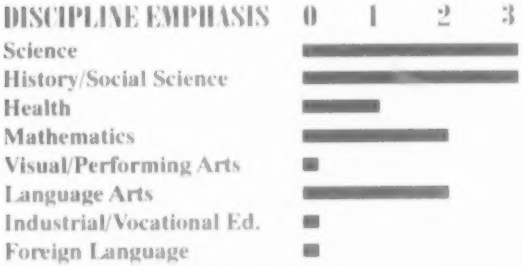
"Wow! The Wonders of Wetlands" is divided into two core parts: an extensive teacher background section followed by 44 activities organized within five chapters: an introduction to wetlands, the wetlands community, the role of water in wetlands, the role of soil in wetlands, and wetlands and people. Background information is cross-referenced to specific activities, designed to be taught thematically and cross-disciplinarily. A glossary, an educational resources section, and an appendix detailing plans for developing a schoolyard wetland habitat are also included.

☁ ☁ ☁ ☁



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	A-
Pedagogy	A
Teacher Usability	A
Water Resources	B+



COMMENTS

General Content
"Excellent sourcebook for K - 12 wetland study." "An interdisciplinary approach." "An exceptional compendium on wetlands information and activities ... wow!"

Presentation
"Segments are well organized for ease of use." "Good illustrations with lots of examples."

Pedagogy
"Lesson format is easy to understand and thorough." "Lessons are self-contained and easily integrated with existing curriculum."

Teacher Usability
"Provides instruction on how to create your own wetlands habitat." "Nice section on background materials for teachers." "Would suggest breaking the document into K - 6 and 7 - 12 sections."

Specific Content on Water Resources
Specifically focuses on wetlands.

Wetland Tradeoffs

[Adapted from "Perspectives" in Project WET Curriculum and Activity Guide. *1995. Produced by Project WET and the Western Regional Environmental Education Council, Bozeman, MT]*

Grade Level
9-12

Subject Areas
Government, Economics, Environmental Science, History

Duration
1 hour

Setting
Classroom

Skills
Gathering, analyzing, and applying information

Charting the Course
Wetland functions are reviewed in "Wetland Metaphors," "Runoff Race," "Wetland in a Pan," and other activities. "Hear Ye! Hear Ye!" provides a sample wetlands debate.

Vocabulary
wetland functions, tradeoffs, values

Summary

What factors should we consider when we decide whether or not to alter a wetland for other uses?

Students make a simple inventory of wetland benefits, then debate the tradeoffs in a local wetlands issue.

Objectives

Students will:

- compare economic, social, and environmental tradeoffs in various wetland conservation and development decisions.
- describe the history of wetland development and protection in their community.

Materials

- *reference materials that identify the various viewpoints about a wetlands issue. Find these in your local newspaper or in national magazines.*

Making Connections

Students may have traded or sold things such as used bikes or crafts. They may not realize that the fate of wetlands often involves the same negotiating practices. Many people live in communities or eat food from lands that were once wetlands. Participation in mock negotiation helps students appreciate the many different values people may or may not place on wetlands. Indeed, people who have the same facts may come to different conclusions. This activity highlights the tradeoffs in wetlands management decisions.

Background

The many functional values of wetlands have far-reaching economic and social benefits (see chapter 3). To touch on a few:

- Recreational fishing and hunting in or near wetland habitats generates income in many ways (e.g., equipment sales, motel rooms, hunting/fishing guides, travel to the site, meals, licenses, duck or fish stamps).
- Seventy-five percent of all commercial fish (including shellfish) species are directly dependent on wetlands at some point in their life cycle. Commercial fishing furthers the sale of equipment, boats, and fuel, and also creates jobs in the food processing industry.
- The fur industry harvests mink, muskrat, beaver, and otter hides and purchases trapping equipment, which supports the retail economy.
- Endangered species and nongame birds and mammals are a wonderment to nature lovers and bird-watchers who buy outdoor gear, binoculars, books, auto fuel, motel rooms, and meals.
- Where some wetlands recharge shallow ground-water wells, homeowners are spared the cost of deep drilling.
- Where wetlands are situated near points of pollution, water-quality improvements from wetlands (uptake of nutrients and heavy metals) can be measured. Wetlands can even be used as wastewater treatment sites, whose absolute benefits are calculable.
- Wetlands in flood-prone areas can store and gradually release peak flows of water. The economic benefits of wetlands for flood control have been calculated.

- In terms of property values, wetlands are seen as both nuisance and amenity. They are a nuisance to some because protective regulations hinder development timelines, but are valuable to others because they add the benefits of open space and wildlife habitat to adjacent property.
- Many people value wetlands primarily for their aesthetic beauty. Regardless of these benefits, controversies arise when people who directly benefit from a wetland are not the people who pay for its protection. And it is true that some people benefit more directly than others. For example, a person who likes to fish in a wetland may value it more than another person who does not enjoy fishing.

Wetlands affect the economy, and the distribution of benefits and costs affects people's opinions about wetlands. Some would prefer to convert wetlands to more highly valued uses (a land practice more financially beneficial to them), while others would prefer to protect wetlands for their ecological contributions.

Procedure

Warm Up

Ask students what they think about wetlands. Why do they think they are important? Why would people want to build in or near a wetland? Why would other people want to protect wetlands? List wetland functions and the benefits and disadvantages of those functions on the board.

The Activity

1. **Distribute among the students the reference materials you have found in local newspapers or national magazines and newsletters. As you discuss the controversies surrounding wetlands, encourage students to think in terms of problems rather than issues (issues divide us, problems are something we can solve).** A newspaper might feature a headline such as: "Developer Seeks Permit to Fill Wetlands For Subdivision." But what is the problem? A problem-solving approach will ask, "How can water quality be protected if this subdivision is approved?" or "Are there alternative plans for protecting the wetland?" or "Can we assure jobs and housing and still protect the environment in this case?"

Wetland Tradeoffs

Community Flooding

Buy Flood Insurance

Still Located in Floodway
Individual or Business Recovers Losses
Shared Expenses and Risk

Build a Dam

Loss of Fish and Wildlife Habitat
Problems with Sedimentation
Regulates Stream Flow
Reduces Potential Flooding
Creates Alternative Habitats for Wildlife
Alters Drainage Patterns
Costly

Move Houses

Impact on Neighbors and Families
Eliminates Future Problems
Costly
Long Term Solution

Create or Restore Wetlands

Reduces Future Flooding
Costly
Could Displace Existing Structures
Creates and Enhances Wildlife Habitat
Long-term Solution
Brings About Other Wetland Benefits (pollution filter, erosion control, etc.)

GRADES 10-12

382

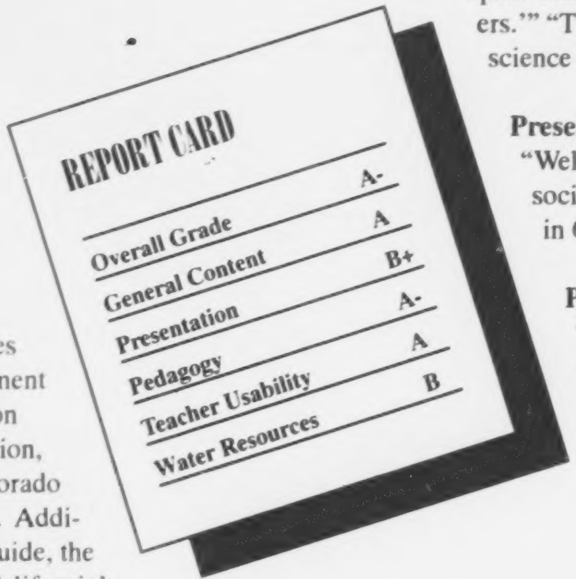
383

Water Politics

Metropolitan Water District of
Southern California
Education Programs
P.O. Box 54153
Los Angeles, California 90054-0153
(213) 217-6398

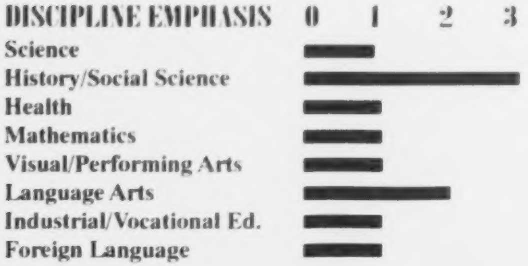
$55.00. Materials are free in MWD Southern California service area. 1994. Binder format.

"Water Politics, a Water Education Program for High School" presents nine case studies focusing on water conflicts in California. Students engage in role-play scenarios emphasizes critical thinking skills in the development of public policy. Case studies focus on water rights, groundwater contamination, risk assessment, the allocation of Colorado River water, and endangered species. Additional materials include a teacher's guide, the "California Water Story" video, the California's Water Resources state map, and unit exams.



REPORT CARD

Overall Grade	A-
General Content	A
Presentation	B+
Pedagogy	A-
Teacher Usability	A
Water Resources	B



COMMENTS

General Content
"The case studies in 'Water Politics' are excellent and well developed. The information is based on *real* scenarios and *real* 'players.'" "This integrates environmental education into the social science class."

Presentation
"Well organized and presented." Fair treatment of the sociopolitical issues arising from water distribution and use in California. "The artwork is beautiful."

Pedagogy
"Very good activities; a wide range of topics is addressed." "Case studies provide engaging premises for student activities and critical thinking."

Teacher Usability
"Because of the heavy curriculur load in science teaching nowadays, these excellent materials might prove too time-consuming to integrate." "This is a great curriculum - fits into the history-social science framework."

Specific Content on Water Resources
Covers California water issues. "Excellent historical and political coverage of water rights." "A Southern California slant."

Table of Contents

Teacher Guide

T2 Overview
T3 Goals and Objectives
T3 Teaching Notes
T3 Time Frame
T3 Lesson Plan
T5 Glossary
T5 Extenders
T6 Unit Test Questions and Answers

Student Book

2 Introduction and Background
3 Possible Solutions
4 The Activity
4 Interest Group Positions
5 Letters from the Public
6 Glossary

Additional Materials

Unit Test
Unit Cards: What Really Happened

Protecting the Quality of the San Joaquin Reservoir

The Interests of Many Versus the Interests of a Few

Overview

The San Joaquin Reservoir illustrates a common social dilemma: a conflict that will either do harm to a few people or harm to a large number of people. Water entering the reservoir has already been disinfected with chlorine. In the open reservoir, the chlorinated water comes in contact with naturally occurring organic materials, such as leaves and twigs. The chemical interaction between chlorine and organic materials in water results in the formation of trihalomethanes (THMs). Although the risk is extremely slight, THMs are suspected to be carcinogenic. The U.S. Environmental Protection Agency (EPA) is re-evaluating the acceptable limits of THMs in a public water supply, and as a result, at some point in the future, the reservoir's water will not meet new federal health standards.

To comply with the new regulations, the reservoir will have to be upgraded or closed, and there are three serious options for what to do:

1) **Build a Treatment Plant**
A treatment plant would require building a new facility. While that facility would not be visible to the homes overlooking the San Joaquin Reservoir, it would be visible to some homeowners somewhere nearby. In addition, siting a facility such as a treatment plant can present other problems, such as chemical storage and wildlife protection. Furthermore, the water entering the San Joaquin Reservoir has already been treated; building an additional treatment plant would result in the water being treated twice, and double treatment could present an additional financial burden on water customers, raising their monthly bill by as much as $3.50. Lastly, the treatment plant is by far the most expensive of the three options.
Cost: $100 million for construction
$12 million annually for maintenance

2) **Cover the Reservoir with a Floating Plastic Cover**
Covering the reservoir with a floating plastic cover would prevent the formation of THMs, but it would also eliminate the water view from nearby homes, an important benefit to some homeowners. Covering the reservoir is the least expensive option.
Cost: $17 million to install
$2.5 million for annual maintenance

3) **Close the Reservoir**
Closing the reservoir would solve the THM problem, but it would strain the existing water delivery system in a number of ways. Reservoirs store water when it is available so there is an adequate water supply during dry periods. The San Joaquin Reservoir stores water so the families within its service area can be confident there will be water every time they turn on the faucet. The water supply system to that part of Orange County does not have any excess water, so taking the reservoir out of service could reduce the reliability of the water supplies for about one-half million people. Excess water storage also is particularly important in the event of an emergency, such as an earthquake. Taking the reservoir out of service is simply not practical.
Cost: Unknown. If the reservoir were closed, it would still require maintenance. It is unclear who would pay for this maintenance if the reservoir were no longer part of the water delivery system.

In this activity, your students will examine the conflict from the perspectives of the homeowners, the water users, and the water supplier; they will discuss options, and they will try to agree on what to do.

Goals and Objectives

In this activity, students will:

- Examine the impact of local government entities, such as planning commissions, on local decisions.
- Examine the interconnection of local decision-making with state and federal regulations.
- Explore issues that must be addressed by government when making a public policy decision.
- Examine a situation in which taking care of the many might have direct negative impacts on a few.

Teaching Notes

- This unit incorporates readings, class discussions and writing.
- The questions addressed by this activity have no right or wrong answers. It is important, therefore, that the students explore these issues rationally and thoughtfully.
- This activity introduces a very important concept: Throughout a democratic society, the majority must take responsibility for protecting the rights of the minority—but that does not always mean going along with the desires of the minority. That concept should be emphasized throughout this lesson.

Time Frame

Two class periods.

Lesson Plan

Homework: Ask students to read the Introduction and Background on pages 2 and 3 of the Student Book and briefly answer the review questions on page 3.

DAY 1

1. **Briefly review the homework reading by discussing the review questions below.** *(These questions also appear on page 3 of the Student Book.)*

Ⓠ Why is the San Joaquin Reservoir important to the Orange County water supply system?

Ⓐ *The reservoir supplies water to about 500,000 water customers in the cities of Costa Mesa, Huntington Beach, Irvine, Laguna Beach and Newport Beach. In addition, as a reservoir, it helps to balance fluctuations in supply and demand within the system.*

Ⓠ Why have trihalomethanes (THMs) become an issue related to the San Joaquin Reservoir?

Ⓐ *Because THMs are a suspected carcinogen and might cause cancer among a small percentage of the population.*

GRADES 10-12

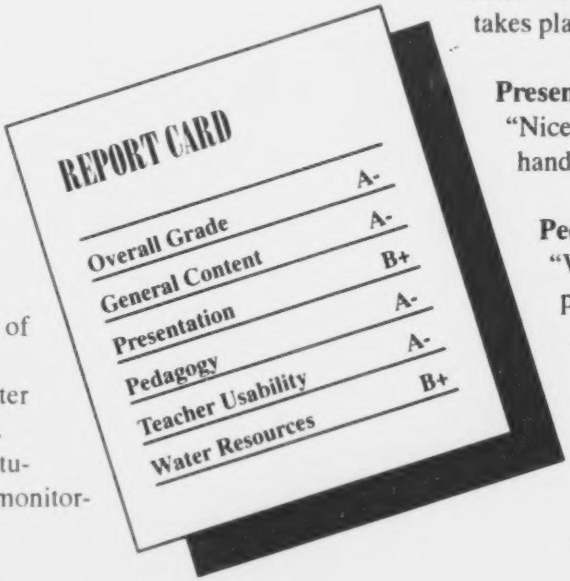
Hands On Save Our Streams

Save Our Streams
The Izaak Walton League of America, Inc.
707 Conservation Lane
Gaithersburg, MD 20878
(800) 284-4952

$18.00. 1995. 201 pages.

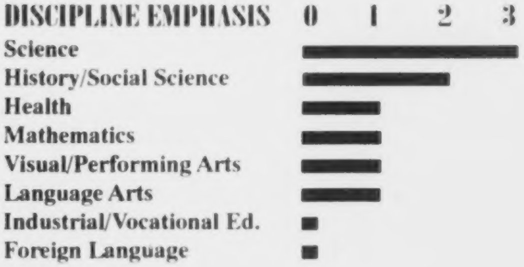
This teacher's manual is based on the grassroots river and stream protection program of the Izaak Walton League of America. Classroom activities integrate science, social science, language arts, and mathematics to introduce the concept of watershed, the hydrologic cycle, the relationship between land use and water quality, and water quality monitoring. Field trips provide opportunities for students to apply skills in water quality monitoring and restoration activities.

☁ ☁ ☁ ☁



REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	A-
Water Resources	B+



COMMENTS

General Content
"A good unit on streams and watersheds and the factors affecting them." "Field work requirement reinforces the idea that learning takes place outside the classroom in the *real world*!"

Presentation
"Nice layout with a glossary and ready-to- reproduce handouts."

Pedagogy
"Well written and very clear ... takes the reader through the processes with clarity of purpose." "Offers excellent lab and field activities."

Teacher Usability
The background information is helpful. "Material requires frequent visits to the field site."

Specific Content on Water Resources
A comprehensive stream focus. "A compact, efficient guide provides good coverage without overkill."

Field Activity #2

Additional physical measurements can be conducted on the stream to help students understand the dynamic stream environment. Students also will get a chance to practice math and cooperation skills. These experiments are designed for shallow streams only. Make sure that stream velocity is not so fast that students could fall down. Classes can decide to conduct any or all of the following experiments. These methods have been simplified for use by students. For more precise methods, consult additional references.

Stream Surveyors

Lesson Time: 10 to 15 minutes per experiment

Objective: Students learn to measure physical parameters of stream flow and morphology.

Experiment 1: Measuring the channel area of a small stream

Key Words:
- Cubic feet per second (Cfs)
- Run
- Flow
- Velocity

Materials:
- 25 foot (or longer) measuring tape that can reach across the stream, or rope with feet and half-feet marked
- Wood stakes
- Red electrical tape or yarn
- Yardstick or measuring staff

Procedure: 1) Choose a section of stream across a run area.

2) Stretch the rope or measuring tape from the left bank top to the right bank top and record the distance. Be sure to either hold the tape taut or attach it to wood stakes on both sides of the bank.

3) Divide the tape into five equal lengths. For example, if the distance is 30 feet, take a measurement every 5 feet and mark the 5-foot intervals with tape or yarn.

4) Next, use the yardstick or measuring staff to record the depth of the stream at each interval. Write your results as follows:

Sample Data Sheet

Measurement	Distance from left bank	Depth
#1	5 ft.	.6 ft. or 6 in.
#2	10 ft.	1.6 ft. or 18 in.
#3	15 ft.	2.6 ft. or 30 in.
#4	20 ft.	2.5 ft. or 29 in.
#5	25 ft.	1.2 ft. or 14 in.

Data Worksheet for Measuring Channel Area

Names of students: ______________________________

Date: ______________ Class: ______________________

Purpose: Determine the channel area of a small stream.

Equipment: Measuring tape, yard stick or measuring staff, tape, pencil and paper.

Instructions for measuring channel area:

1) Choose a section of the stream where channel width is about average for the stream.* Stretch the measuring tape across the stream and record the distance. One student should hold the tape at each end.
2) Divide the total distance by five and use tape to mark each increment.
3) Next, use the yard stick or measuring staff to record depth at each increment.

Record results below:

Measurement	Water Depth (feet)
Measurement #1	________
Measurement #2	________
Measurement #3	________
Measurement #4	________
Measurement #5	________

Add depth measurements #1 through #5 together and divide by the total number of measurements to get average depth.

#1_____ + #2_____ + #3_____ + #4_____ + #5_____ = _____ ÷ 5 = _____ avg. depth (ft.)

Using the principle that area = length x width, determine channel area.

length _____ (feet) x average depth _____ (feet) = _____ channel area (sq. ft.)

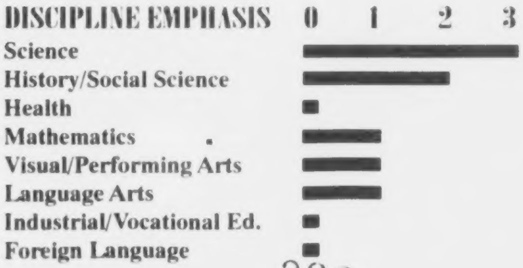
*Note: You can measure channel area for a pool, riffle and run to determine average channel area.

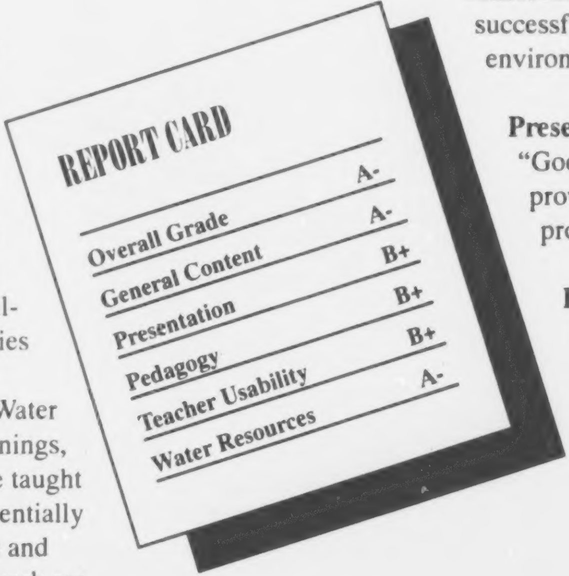
A Sense of Water

Southern Arizona Water Resources
Association
48 North Tucson Boulevard, #106
Tucson, Arizona 85716
(520) 881-3939

Publication is no longer available for purchase. Permission is granted for teachers to reproduce the material for education use only. 1984. 150 pages.

"A Sense of Water" provides a broad range of water-related activities with particular emphasis on water availability in the arid Southwest. The activities are organized in six sections: Water Magic, The Wonders of Water, Less Water Climates, Water Working, Water Warnings, and Water Wisdom. Activities can be taught independently of one another or sequentially within a water unit. A glossary, topic and subject index, and conceptual framework are offered.





REPORT CARD

Overall Grade	A-
General Content	A-
Presentation	B+
Pedagogy	B+
Teacher Usability	B+
Water Resources	A-

COMMENTS

General Content
"Offers well-organized, comprehensive activities" which emphasize conservation and water management in arid environments. "This successfully creates a true feeling of caring and concern for the environment."

Presentation
"Good breakdown of activities and subject area focus is provided at the end of the book." "Photographs and graphics provide visual appeal."

Pedagogy
Integrates several subject areas. "Geared primarily to junior high - middle school."

Teacher Usability
Evaluation devices are lacking, as are student handouts.

Specific Content on Water Resources
A regional emphasis upon Arizona, although adaptable for California. "Written in 1984 and some of the issues may have changed."

392

393

355

A Letter from Archy

objective

Students will be able to:

- Describe conditions which led to the "dust bowl" era of the 1930s and identify possible ways to avoid repeating those conditions.

activity

Ask all students to read, or one student to read aloud, "a letter from archy," excerpted below from the life and times of archy and mehitabel by Don Marquis.

Then ask the students to discuss questions such as the following, pursuing additional information where necessary to the discussion.

- Who was archy? (A cockroach!)
- What was taking place in the United States at the time (1935) archy wrote his letter? How accurate was archy's description of the situation?
- What did archy predict about the destiny of the human race as a result of humanity's activities? How accurate are his predictions?
- How accurate was archy's description of the causes for the downfall of the civilization he describes?
- Do you think humanity has taken archy's warning seriously and reformed? What evidence can you cite for your opinion?
- What actions are being taken to avoid the conditions archy describes? Are there other actions we ought to be taking but as yet are not?

extensions

1. Ask your students to examine the style of writing used by archy (Marquis). Why didn't archy capitalize? (As a cockroach, archy couldn't operate the upper case key on the typewriter!) Ask each student to use the same style to write a reply from mehitabel defending exploitation.
2. Talk about the conditions of the people and the land during the dust bowl era. Compare archy's description with literature like The Grapes of Wrath, by John Steinbeck, or a film on the dust bowl era.

Discuss how lack of rainfall could change a whole segment of society's lives: where they live, how they live and how they make a living.

Chapter Reference

Less Water Climates

Grades

9–12

Subject

Language Arts and Humanities, Social Studies, Science

Length of Activity

One classroom session

Concept

Hydrological conditions create humid and arid areas on the earth. (A)

Credits

Project Learning Tree

Copyright 1977, 1975 The American Forest Institute, Inc.

Contact

Grapes of Wrath, by John Steinbeck

National Geographic, August 1984

---

notes

A LETTER FROM ARCHY
by Don Marquis

dear boss i was talking with an ant the other day and he handed me a lot of gossip which ants the world around are chewing among themselves

i pass it on to you in the hope that you may relay it to other human beings and hurt their feelings with it

no insect likes human beings and if you think you can see why the only reason i tolerate you is because you seem less human to me than most of them

here is what they are saying

it wont be long now it wont be long man is making deserts on the earth it wont be long now before man will have used it up so that nothing but ants and centipedes and scorpions can find a living on it

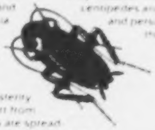
man has oppressed us for a million years but he goes on steadily cutting the ground from under his own feet making deserts deserts deserts

we ants remember and have it all recorded in our tribal lore when gobi was a paradise swarming with men and rich in prosperity it is a desert now and the home of scorpions ants and centipedes

what man calls civilization always results in deserts man is never on the square he uses up the fat and greenery of the earth each generation wastes a little more of the future with greed and lust for riches

north africa was once a garden spot and then came carthage and rome and despoiled the storehouse and now you have sahara sahara ants and centipedes

toltecs and aztecs had a mighty civilization on this continent but they robbed the soil and wasted nature and now you have deserts scorpions ants and centipedes and the deserts of the near east followed egypt and babylon and assyria and persia and rome and the turk the ant is the inheritor of tamerlane and the scorpion succeeds the caesars



america was once a paradise of timberland and stream but it is dying because of the greed and money lust of a thousand little kings who slashed the timber all to hell and would not be controlled and changed the climate and stole the rainfall from posterity and it wont be long now it wont be long till everything is a desert from the alleghenies to the rockies the deserts are coming the deserts are spreading the springs and streams are drying up one day the mississippi itself will be a bed of sand ants and scorpions and centipedes shall inherit the earth

men talk of money and industry of hard times and recoveries of finance and economics but the ants wait and the scorpions wait for while men talk they are making deserts all the time getting the world ready for the conquering ant drought and erosion and desert because men cannot learn

rainfall passing off in flood and freshet and carrying good soil with it because there are no longer forests to withhold the water in the billion meticulations of the roots

it wont be long now it wont be long till earth is barren as the moon and sapless as a mumbled bone

dear boss i relay this information without any fear that humanity will take warning and reform

signed archy

From the life and times of archy and mehitabel by Don Marquis (New York: Doubleday & Co., 1935). Reprinted by permission.

Project Water Science

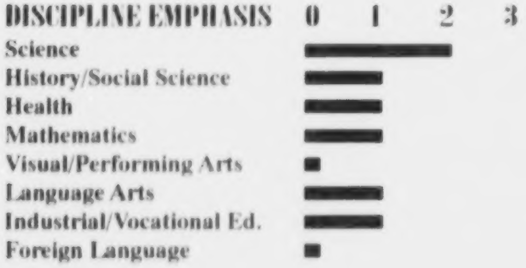
Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

$20.00. 1995. Package format.

"Project Water Science" is a collection of water education materials designed as a water chemistry unit of study. The Teacher's Guide (39 pages) offers hands-on activities that focus upon water quality, water and the environment, and water and people. Materials also include the Layperson's Guide to Drinking Water (20 pages), a Water Fact Card, a pull-out Nonpoint Source Pollution Game, the California Water Map, and the California Waterways Poster.

REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	B+
Teacher Usability	B
Water Resources	A-



COMMENTS

General Content
A variety of activities deal with water quality issues, environmental impact, and the human element.

Presentation
"Great maps!" "Excellent student materials with a hands-on orientation to activities." "The page layout is interesting and appealing."

Teacher Usability
"Clear teacher instructions and solid background information." "The drinking water guide provides excellent background information." "The Water Fact Card provides quick, easy access to startling information."

Specific Content on Water Resources
"Lacks a discussion of water reclamation and regional control of water rights."

Surveying A Watery Biome

Water Clarity

LAB
6b

Background Reading

The presence of different kinds of organisms living in an aquatic ecosystem is determined by various aspects of water quality.

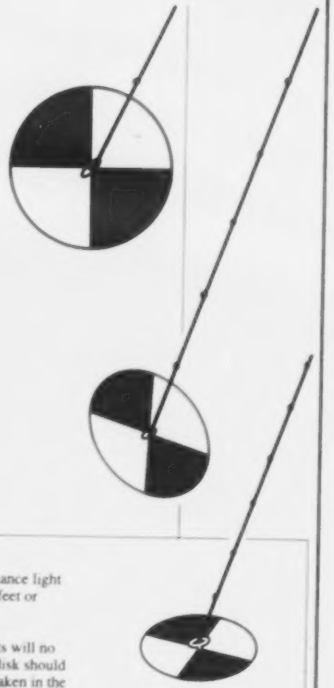
It is important to remember that physical, chemical and biological factors all interact. For example, an overgrowth of **algae** caused by sewage runoff may cause a severe reduction of dissolved oxygen in the water, which will threaten the survival of various aquatic animals. It is important to analyze as many aspects of the aquatic environment as possible to get a clear view of what is occurring.

The presence of some aquatic plants and animals may not be a clearly reliable indicator of what is happening, because some plants and animals can grow in polluted, as well as an unpolluted, environment. However, biological data, along with physical data, are an important part of the total picture.

This Lab will enable you to gain experience in using your senses to look at an aquatic ecosystem. Some equipment will be used as an extension of your senses. Secchi Disk readings can give an indication of the amount of productivity of living materials in water. In very productive waters, light penetration will be limited by the presence of billions of tiny organisms. Clear water is an indication of low productivity of living organisms.

Question

How is water clarity related to productivity of living organisms in a fresh water habitat?

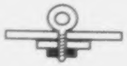


Instructions for making a Secchi Disk

The Secchi Disk is used to determine water clarity by measuring the distance light penetrates into the water. The disk is lowered with a line marked off in feet or meters until it just disappears from sight.

This is known as the Light Compensation Level, the point at which plants will no longer grow from the bottom of the pond. The conditions for using the disk should always be standardized: clear sky, sun directly overhead, with readings taken in the shade.

The Secchi Disk is a circular plate 20 cm in diameter. It can be made out of 1/4" or 3/8" marine grade plywood or 18 gauge metal. The upper surface of the disk is divided into four equal pie shapes, with each quadrant painted alternately black and white with semi-gloss enamel paint. The undersurface is painted black. The center of the disk is drilled and a weight and eye bolt are attached. A line which has been accurately calibrated in meters is attached to the eye bolt.



Materials needed

1. Secchi Disk
2. hand screen, nets, kitchen sieve, coffee can and hand lens
3. pans to hold collected species

Procedure

1. Examine a sample of pond water. Either observe small container of water with a hand lens or look at drops of water under a microscope.

Record your observations

2. Use the Secchi Disk to determine the limits of visibility in the water. Lower the Disk until it just disappears from view and record the depth. Lift the Disk and record the depth at which it reappears. The average of the two readings is the limit of visibility. Take at least three sets of readings and record each of them to the nearest 1/4 of a meter. Average your answers below.

Record

Lower Secchi Disk		
1. Depth at which Disk disappears		■
Depth at which Disk appears		■
Average of two depths	■	
Do this procedure a total of three times		
2. Depth at which Disk disappears		■
Depth at which Disk appears		■
Average of two depths	■	
3. Depth at which Disk disappears		■
Depth at which Disk appears		■
Average of two depths	■	
4. Average all three answers	■	

Questions

1. Was the water clear or cloudy?____________________

2. What organisms are present?

____

____

____

3. How organically productive is this water?

____

____

____

Conclusion

____

____

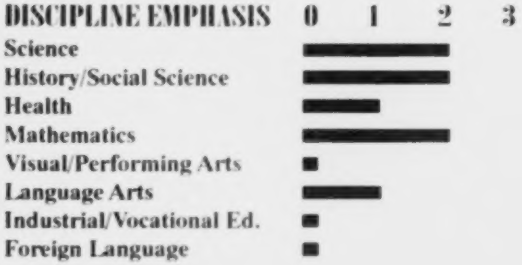
____

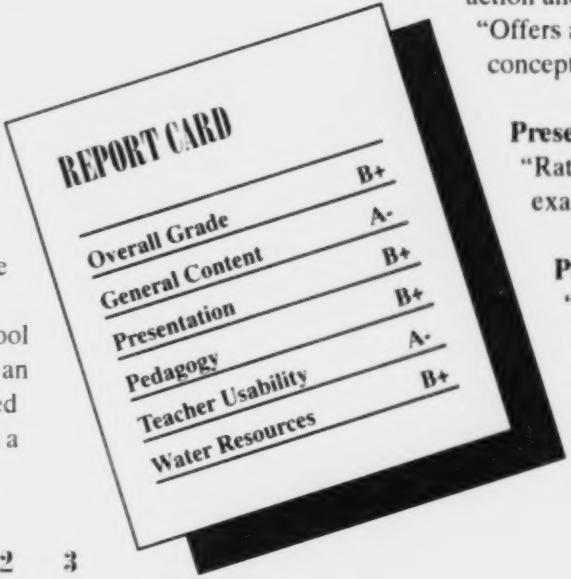
Water Wisdom

Massachusetts Water Resources Authority
100 First Avenue
Boston, Massachusetts 02129
(617) 241-4643

No charge. 1990. 179 pages.

"Water Wisdom" offers secondary level activities on water supply and conservation. Twenty-four activities encompass the following areas: the water cycle, water and society, water treatment, water volume concepts, the economics of water, domestic water conservation, and school water audits. The appendices include an annotated bibliography of water-related literature, water dilemmas, a glossary, a resource list, and reproduced articles.





REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	B+
Teacher Usability	A-
Water Resources	B+

COMMENTS

General Content
"Primarily deals with how to conserve water through personal action and improvement of the infrastructure delivering water." "Offers a variety of activities which clearly reinforce specific concepts." "News articles provide the link to everyday life."

Presentation
"Rather dry treatment which continually uses local and state examples (Massachusetts)."

Pedagogy
"The school audit program is a good application." "Offers a collection of twenty-four stand alone activities on water supply conservation."

Specific Content on Water Resources
"Addresses water as a finite resource and fully explains and demonstrates its movement through the environment." "A good source of activities for areas not normally covered in other packages, such as transpiration, evaporation, leak detection, and economics of water use." Activities are geographically specific to Massachusetts, but can be adapted to other regions.

#10 Water Purification
Student Activity

Background

Water entering the MWRA / MDC reservoirs is quite pure and requires little treatment. In this exercise, you will learn two ways that the MWRA water is purified: filtration through the soil and rock of the watershed aquifers, and by standing in the reservoir system so that sedimentation removes most of the particulate matter.

At present, water we receive from the MWRA requires only the natural process of sedimentation and the addition of small amounts of chlorine to kill harmful bacteria. At normal reservoir levels, any one molecule of water entering the reservoir from the watershed stays in the reservoir for as much as four years before moving into the distribution system. This length of time allows gravity to pull the slightly heavier solid particles to the bottom of the reservoir. If we continue to use more water than rain is able to replace, the reservoir levels will continue to drop. As a result, less time will be available for sedimentation and additional filtering treatment may be required.

There is a second reason why water may have to be filtered in the future. When water contains small particles of clay and other substances, it appears cloudy. The water is then described as being ***turbid***. The federal government has set ***turbidity*** standards for water and MWRA water meets current standards. But, if federal turbidity standards become stricter, the MWRA may have to begin filtering its water supply.

So if we continue to overuse our water supplies or if the federal government tightens its turbidity standards, artificial filtration may be required. What would happen? The MWRA would have to pay to build and maintain a filtering plant. For now, at least, nature – with a little help from us – is doing a fine job of cleaning our water...as you will see.

Procedure

1. Your teacher has a supply of untreated water. Using one of your 250 ml beakers, obtain slightly more than 200 ml of the water.

2. Carefully measure 200 ml of this water into your 250-ml graduated cylinder. Dispose of the rest of your sample and rinse out your beaker.

3. Carefully observe your sample. Record its color, clarity, odor and presence of solids in the appropriate spaces in Table I on the data sheet provided.

4. Cover your graduated cylinder with a piece of paper labeled with your name and allow it to stand overnight.

On Day II:

Sedimentation

1. Without disturbing your graduated cylinder, again observe your sample and record your observations on the data table.

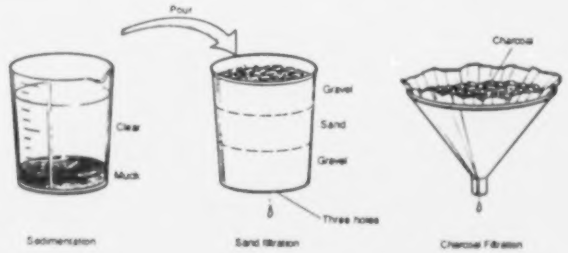
2. Estimate how much water in your graduated cylinder is clear. Record the amount in Table I.

Sand Filtration

1. Use the end of the wire of a large, opened paper clip to make three small holes near the center of the bottom of a paper cup. The holes should be close enough to each other so that they can be blocked by your thumb or finger.

2. Build a miniature sand-filtration device.
   a. Place a layer of fine gravel 2 cm thick on the bottom of the paper cup.
   b. Add about 4 cm of fine sand on top of this gravel layer.
   c. Add another 2 cm layer of gravel on top of this layer.

3. Pour the water from your graduated cylinder gently into the cup. Catch the filtered liquid in a beaker as it drains.



The Stream Scene

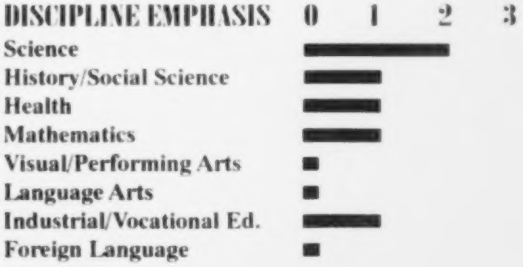
Oregon Department of Fish and Wildlife
Office of Public Affairs
P.O. Box 59
Portland, Oregon 97207
(503) 872-5264

$15.00. 1992. 208 pages.

"The Stream Scene - Watersheds, Wildlife and People" provides an overview of watershed systems, specifically watersheds and riparian ecosystems, the water cycle, hydrology, water quality, and aquatic biology. Activities ultimately prepare students to conduct field investigations. Background information, reproducible worksheets, and five appendices including a make-and-take field equipment section are included. Portions of "Project WILD" and "Aquatic Project WILD" complement this curriculum.

REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	B+
Teacher Usability	A-
Water Resources	B+



COMMENTS

General Content

"This material has a real focus on habitat study... an excellent resource." "A strong program for stream biology [specifically temperate, freshwater trout - salmon streams]." "Field work is an essential part of the learning process."

Presentation

"A conveniently laid out guide."

Pedagogy

"Lots of cooperative learning experiences; could be powerful."

Teacher Usability

"This is a great resource for teachers who want to have a program geared to a lake or other aquatic habitat." "Directions on how to make field equipment are given in an appendix." "Teacher section provides a wealth of helpful information."

Specific Content on Water Resources

Focus is upon freshwater habitats. "Although based on Oregon data, it is *real* data the students study." "Concentrates on aquatic organisms..."

VI.2

Water quantity

"Don't pray for the rain to stop. Pray for good luck fishing when the rivers flood."
— Wendell Berry

The quantity of water directly affects plants and animals that live in a stream and humans that use it. *Volume and velocity are key dimensions of water quantity.* These change with the season and are influenced by human actions, soil movement from erosion and landslides, and vegetation changes from fire, logging, grazing, disease and windstorms.

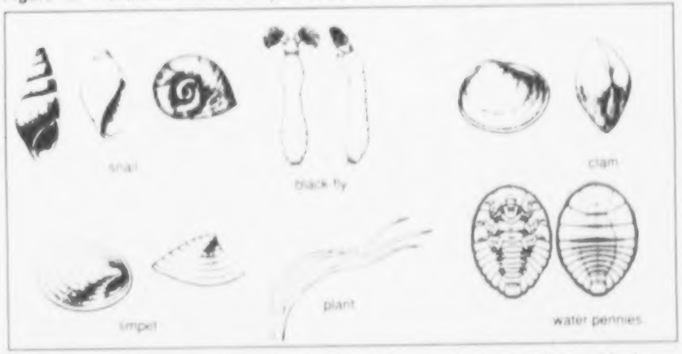
The volume of water affects composition of the streambed by moving and depositing sediments and debris. Fast-moving water carries more and larger material. The channel of a rapidly moving stream will have larger material, but a slowly moving stream will have a bed covered with mud and silt.

Velocity

Flow velocity is one of the main factors that determines the character of a stream. Velocity directly influences:

- Dissolved oxygen (DO) concentration through aeration at the surface
- Water temperature through evaporation

Figure 10. Plant and Animal Adaptations to Water Velocity



Source: Kenneth W. Cummins and Margaret A. Wilzbach, *Field Procedures for Analysis of Functional Feeding Groups of Stream Macroinvertebrates*, 1985.

A study in streamflows

GRADES 10-12

Objectives

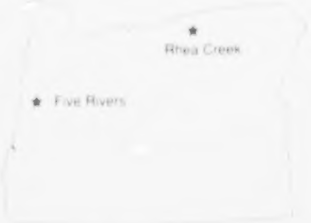
Students will (1) examine annual streamflow rates for two Oregon streams; (2) compare streamflows in an eastern Oregon stream and a western Oregon stream in terms of peak flows, critical periods, and related water quality aspects; (3) calculate the number of people who could be supported by average and minimum streamflows in these streams; and (4) predict how streamflow patterns can affect fish, wildlife, and human populations.

Method

Students will graph annual streamflow patterns for two Oregon streams—one representative of eastern Oregon and one representative of western Oregon—then compare and contrast the two. In addition, students will calculate and compare how many people could be supported by the discharge (streamflow) in these streams.

Materials

Copies of student sheets (pp. 77-84)



Background

Do you know . . .

The amount of water in a stream varies throughout a year. Some of this variation can be predicted because it is related to the climate (weather) of a region. Other variations are harder to predict, because they are caused by removal of watershed vegetation, associated with urban development, agricultural practices, and logging and grazing practices.

When the vegetation is removed, the soil cannot store and hold as much water. This means more water will run off the watershed, creating higher peak flows. Higher flows carry more sediment and erosion of stream channels is greater. Less water storage in the watershed also means lower minimum flows during dry periods, leading to higher water temperatures and reduced oxygen.

People manage watersheds so the water in the watershed may be used to the best advantage for the resource and all other concerns. It is easy to imagine how many uses there are for a stream's water—human drinking water, irrigation for crops, hydroelectric power, water transportation, and the needs of aquatic and terrestrial life, to name a few. When decisions must be made regarding what uses will have priority over a year's time, it is necessary to predict peak and minimum flows.

Obviously, it is beneficial to all uses to store water in a healthy watershed. Disturbed watersheds cannot store as much water and much of the water goes to waste. Water management is tricky business!

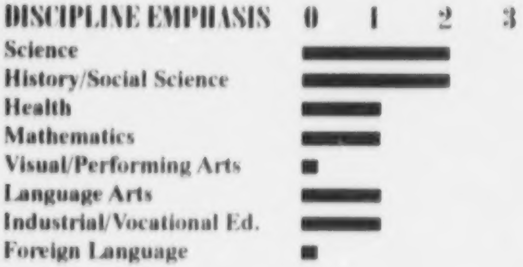
In the Pacific Northwest, precipitation comes primarily in the form of rain or snow, and lowest streamflows generally occur in late summer. Also, rainfall tends to affect streamflow more quickly than snowfall. Streams with snow as a water source tend to experience peak flows later in the spring when the snow is melting.

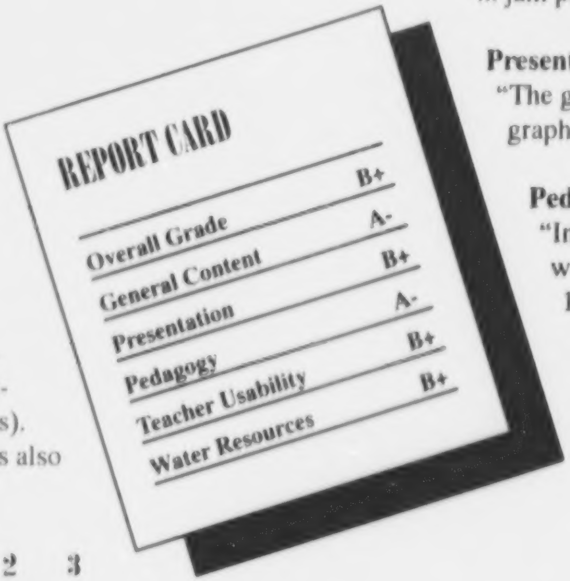
Ground Water Education

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

$20.00. 1995. Package format.

"Ground Water Education" offers lesson plans and materials that focus on groundwater, aquifers, and groundwater pollution. Laboratory sessions and classroom activities, together with reproducible worksheets, overhead masters, background information, role-playing scenario, resources, and glossary, are outlined in the Teacher's Guide (55 pages). The California Ground Water poster is also included.





REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	B+
Water Resources	B+

COMMENTS

General Content
Very good treatment of groundwater issues.
"... jam packed with great ideas, activities, *ad infinitum.*"

Presentation
"The groundwater diagrams are a great addition!" "[Excellent] graphics are designed to reinforce written material."

Pedagogy
"In-depth activities involve hands-on learning about ground water." "Material is more appropriate for grades 7 - 9 than 10 - 12."

Teacher Usability
"Clear teacher instructions." "The colors of some material may not lend themselves to clear duplication." "The activities use simple, available equipment."

Specific Content on Water Resources
Focuses thoroughly but exclusively on groundwater.

Note: In this compendium, the term "groundwater" has been spelled as one word. The term is spelled as two words in specific "Ground Water Education" materials.

409

403

How Much is Too Much?

Parts per million or billion

Introduction

The Safe Drinking Water Act authorizes the U.S. Environmental Protection Agency (EPA) to establish standards for chemicals and other contaminants which may be found in ground and surface waters. The national standards are enforced by the individual states. The primary standards are health based and are usually given a number called the Maximum Contaminant Level. This is a number which is associated with no adverse health effects, taking costs and technology into consideration.

These standards are usually listed in parts per million or billion (ppm or ppb), which is equivalent to milligrams per liter or micrograms per liter. This concept must be understood in order to evaluate figures which are given for different levels of water quality standards. You may want to refer to the *U.S. EPA Region IX Drinking Water Standards and Health Advisories Table* or EPA's *Citizen's Guide to Ground Water Protection*. For more information, call the Safe Drinking Water Act Hotline: 1-800-426-4791

Toxics in Drinking Water — a partial list

Substance	Possible source or use	Possible health effect	Standards (Ppb) EPA	CADOHS
Arsenic	pesticides mining industry	nervous system damage	50	50
Mercury	paints paper manufacturing	kidney, nervous system damage	2	2
Nitrates as N	fertilizer animal wastes	damages ability of blood to carry oxygen to cells	10,000	45,000 as NO3
Selenium	naturally occurring, can be concentrated by human activity	gastrointestinal damage	50	50
Trichlorethylene	waste from dry cleaning materials pesticides, paints, degreasers	carcinogenic	5	5
PCB (Polychlorinated biphenyls)	strengthens plastics insulation on electrical equipment	carcinogenic	5	5

Objective

Students will:

1. Perform a serial dilution using powers of 10.
2. Measure two indicators of water quality, pH and chlorine level.
3. Identify the importance of standards in evaluating ground water and drinking water.

Materials (per group)

- 1 evaporation dish or 9 clear containers or white plastic spoons
- 2 droppers
- white paper
- toothpicks
- food coloring
- water samples (from wells if possible)
- pool or spa testing kit

Part A:
Parts per million or billion
Background Information

Substances dissolved in water are usually measured in parts per million (ppm) or parts per billion (ppb). But how diluted is that? Different naturally occurring elements, toxins or poisons are considered hazardous at different concentrations. Not all man-made chemicals are toxic and not all naturally occurring chemicals are non-toxic. Just about any substance, synthetic or "natural" can be considered toxic if ingested in a high enough dose. Salt is a good example. Sodium chloride is a naturally occurring chemical. A few grains sprinkled on your dinner is okay, but if you ate a couple of pounds per hour, you would do significant damage to your body. According to the U.S. Environmental Protection Agency (EPA), the chart shows maximum contamination levels allowed for drinking water in parts per billion. (Each state may choose to enforce stricter standards; the California Department of Health Services [CADOS] levels are listed on right.)

Student Directions

1. *Put down sheets of white paper or toweling. Line up 9 clear containers or white plastic spoons. Label #1-9.*
2. *Put 10 drops of food coloring in #1. Food coloring is already at a dilution of 1:10.*
3. *Take one drop from #1 and place it in container #2. Add 9 drops water with a clean dropper and mix with a toothpick.*
4. *Repeat this process in each container. (Example: Take one drop from #2, put in #3, add 9 drops of water, stir.) Each dilution will be 10 times more dilute than the previous one.*

Data Table

Container	Dilution
1	1:10
2	1:100
3	
4	
5	
6	
7	
8	
9	

Discussion

1. Which container was at a dilution of 1 part per million? ________ Which one was at 1 part per billion? ________
2. In which container could you no longer see the color? ________
3. In the last container, was there any food coloring present? ________
4. One day Jack was spraying weeds along his fence when the dog accidentally knocked over the open pesticide container, spilling 4 gallons of 2.4 D (pesticide for killing weeds). That night a heavy rain soaked the ground, carrying the pesticide down into the aquifer beneath Jack's house. Maximum allowable concentration of 2.4 D in drinking water is 70 ppb. Assuming there are 400,000 gallons of water in the aquifer beneath Jack's house, would the water being pumped up from Jack's well be safe to drink?

____

____

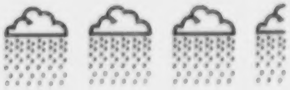
(Hint: Set up a proportion with the number of gallons spilled over the number of gallons in the aquifer and the unknown x over 1 billion.)

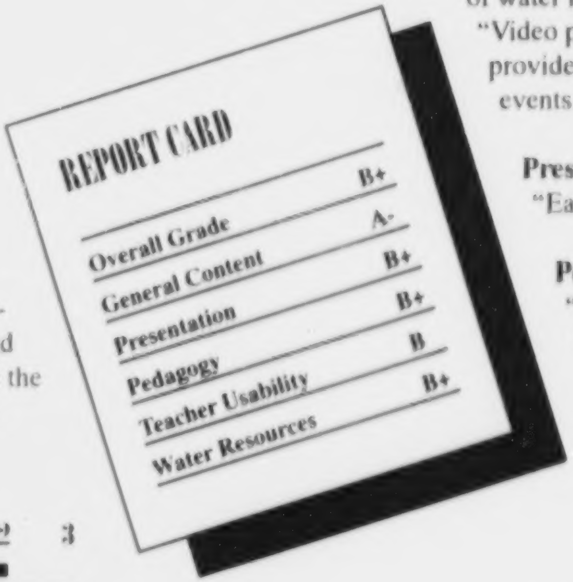
H20 - 2010

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

$25.00. 1995. Package format.

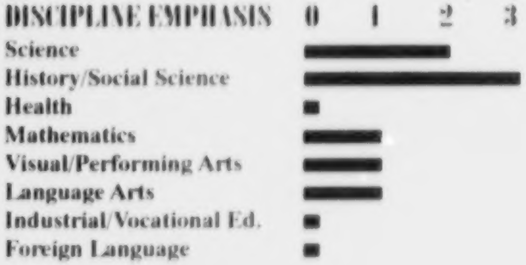
"H2O-2010" focuses on current and historic water issues in California. The six lesson plans offered in the Teacher's Guide (18 pages) examine water use conflicts, the geography of California water, water use in agriculture, business, and industry, water quality and conservation, and groundwater rights. Materials include the "H2O-2010" video and the California Water Map .





REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	B+
Teacher Usability	B
Water Resources	B+



COMMENTS

General Content

"Six activities use a variety of learning modes to create awareness of water issues."

"Video provides excellent background information." "Material provides historical perspectives relating past actions to present events and possible future ones!"

Presentation

"Easy to follow format."

Pedagogy

"The simulations and debatable issues peak student interest."

Teacher Usability

Appropriate for a history and social science curriculum. "Video [because of the "magic" hat] may not be age-level appropriate for 11 - 12 grades."

Specific Content on Water Resources

Offers an introduction to the major aspects of California water use."

412

413

ACTIVITY 5

Water Quality... What's the problem?

Objectives:
Students will:
•identify and study potential degraders of water quality
•prioritize water quality problems in California

Teacher Instructions:
Introductory Discussion:
•Before class: Duplicate the reading "Good Drinking Water" (page 14).
•Ask students if they think their water is safe to drink. Ask them what they think might be in water that could make it unsafe to drink. Ask how water treatment plants treat water.
•List the following potential hazards in drinking water on the board:
Disease causing microorganisms
Lead
Trihalomethanes (THMs)
Radon
Volatile organic chemicals
Nitrates
Asbestos
•Divide the class into seven groups and have each group choose one of the above categories.

Assignment:
Each group is to gather information about why their topic is a hazard to drinking water by answering the following questions:
What is it?
Why is it dangerous?
How does it get into water?
How can it be removed?
How might it be prevented from getting into water?

Follow up Discussion:
Each group should give a brief oral report. Then ask students to prioritize the problems from most serious to least serious. Each student should make his/her own priority list with #1 the most serious and #7 the least. Tabulate the results and share with the class.

Extension Activity:
•Ask a representative from your local water treatment plant to speak to the class about local water treatment procedures and potential problems.

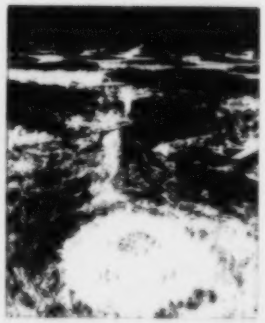
ACTIVITY 6

Ground Water Rights Law - a Simulation

Objectives:
Students will:
•demonstrate an understanding of the conflicts between the different doctrines of water rights law by defending a decision concerning a ground water rights dispute.

Teacher Instructions:
•Discuss the water rights doctrines to clarify definitions.
•Ask for volunteers to play the parts of the factory owner and the three landowners. Everyone else in the class plays the collective role of "the judge." "The judge" can ask questions of the factory owners and the landowners. (Ex.: How much water do you use per day? What do you use water for? How long have you been using water at this rate? etc.) Each student should render a decision in writing about what "the judge" should decide to do in regard to the usage of the ground water by the chemical factory owner and the landowners.

Information source: *Layperson's Guide to Water Rights Law*, Western Water Education Foundation.



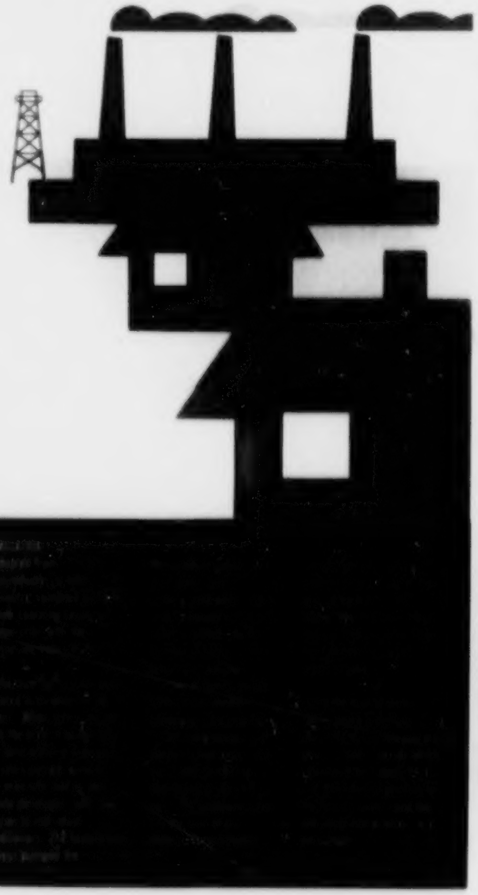
Ground water [illegible] pumped [illegible] Sacramento Valley in 1991 [illegible] providing the main water supply [illegible] Californians [illegible]

STUDENT PAGE

GROUND WATER RIGHTS LAW SIMULATION

Laws concerning surface water:
• Appropriative rights - rights based on physical control of water and since 1914 used by right of permits or license for its beneficial use.
• Prescriptive rights - rights assumed by asserting a title to water on the basis that the prior right has become invalid or unenforceable by lapse of time and specified conditions.
• Pueblo rights - water rights possessed by a municipality which, as a successor of a Spanish law pueblo, is entitled to the beneficial use of all needed, naturally occurring surface and ground water of the original pueblo watershed.
• Riparian rights - rights to water in a river, stream, pond, lake or well-defined underground channel which physically touches the land owned by a property holder.
• Reasonable and beneficial use doctrine - A state constitutional requirement that all water resources must be put to the best possible use, preventing waste or unreasonable use or unreasonable method of use.
• Public Trust Doctrine - holds that the state has to consider those values, primarily environmental, that are held in trust for the people. Now long standing water rights can be challenged.

(KEEP IN MIND THAT LAW GOVERNING GROUND WATER IS OPEN TO DEBATE IN CALIFORNIA. PRESENTLY THERE IS NO STATEWIDE GROUND WATER REGULATION.)

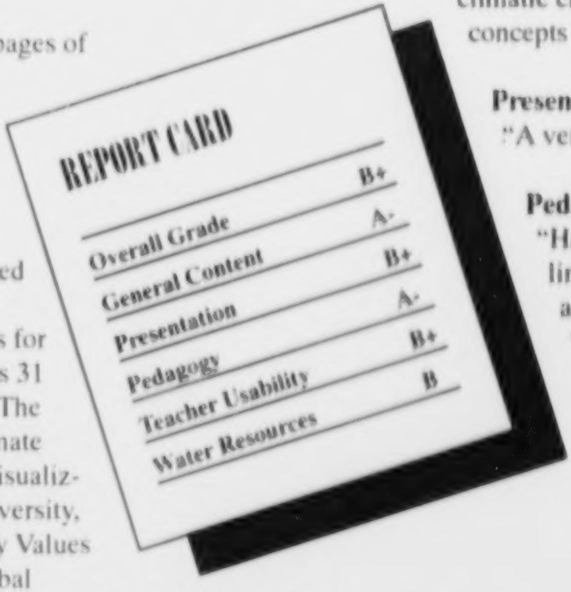


Global Change for the Great Lakes Region: Scenarios and Activities

Ohio Sea Grant
Ohio State University
1314 Kinnear Road
Columbus, Ohio 43212-1194
(614) 292-8949

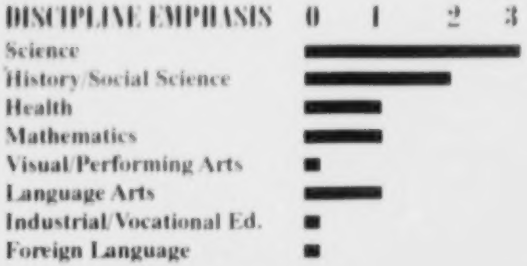
$9.00 for both publications. 1995. 203 pages of activities and 10 scenarios.

These materials focus on the Great Lakes region and specifically upon water resources and the impact of global change. Designed to be used in conjunction with the ten scenarios offered in "Global Change in the Great Lakes," the "Great Lakes Instructional Materials for the Changing Earth System" book offers 31 activities covering the following areas: The Great Lakes in Perspective, Global Climate Change, Great Lake Climate Factors, Visualizing Changes in the Earth System, Biodiversity, Life Support for an Aging Lake, Estuary Values and Changes, Toxic Chemicals and Global Change, Agriculture and Climate Change, Great Lakes Shipping and Lowered Lake Levels, Recreation, and Environmental Response.



REPORT CARD

Overall Grade	B+
General Content	A-
Presentation	B+
Pedagogy	A-
Teacher Usability	B+
Water Resources	B



COMMENTS

General Content

"Uses a systems approach incorporating the effects of global climatic change. Abundant use of climate data helps to develop concepts of change" in a large freshwater system.

Presentation

"A very traditional approach to design."

Pedagogy

"Has very good potential for integrating activities with on-line contact with various groups." "Most of the activities are paper labs involving an analysis of existing data." "The 'Scenario' handouts provide relevant information." Material is geared to students with higher thinking skills.

Teacher Usability

"Its regional focus may *unnecessarily* discourage its use in the west." "The section labeled 'Teachable Moment' alerts teachers to general concepts and skills that need to be discussed and reinforced - a great addition!"

Specific Content on Water Resources

A unique study of the Great Lakes area. "The principles and concepts have a global application."

Activity: How will global warming affect spawning success of Great Lakes fish?

This activity consists of two parts. The first pertains to the effect of lower lake levels on spawning and nursery grounds, and the second pertains to the effects of increased temperature and the ability of fish to migrate to favorable temperatures. These are then combined to help the students anticipate the future of specific fish populations in the Great Lakes if global warming were to occur.

OBJECTIVE

Students should be able to summarize effects of lake level change on the spawning and nursery grounds of given fish in the Great Lakes, using Lake Erie examples.

PREPARATION

- Copy the Western Basin of Lake Erie maps for each lab group.
- Copy fish sheets so that each group gets a description of one fish with the accompanying picture and map of spawning and nursery grounds.
- Copy an outline map of North America for each group.

PROCEDURE

Part 1: Lower lake levels and spawning grounds

1. Students should be divided into groups so that each group studies a different fish.

Each group of students should:

2. Obtain a fish sheet and a Western Basin Lake Erie map.
3. Transfer information from the given fish map concerning spawning and nursery grounds (on fish sheet) to the Western Lake Erie map with actual depths. Remember to enlarge the information (the circles that indicate spawning areas) while transferring them from a small to a larger scale map.
4. Set up a chart and record the amount of spawning and nursery areas before the predicted global warming.
5. Draw a line depicting a 3 meter lake level drop on the Western Basin Lake Erie map in order to determine which spawning and nursery areas would remain usable.
6. Set up another chart and record the amount of the original spawning and nursery area that remains with the new lake level.

Earth System Understanding

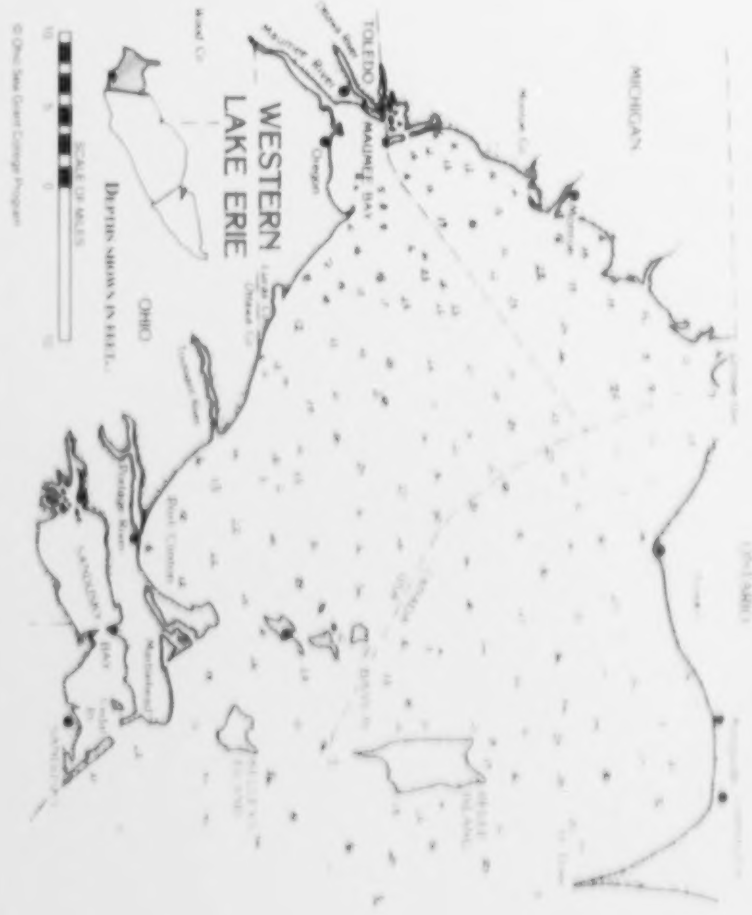
[illegible]

Scenario Reference

[illegible]

Materials

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- outline map of North America


WESTERN LAKE ERIE
DEPTHS SHOWN IN FEET
SCALE OF MILES
MICHIGAN
ONTARIO
OHIO
TOLEDO
MAUMEE BAY
Maumee River
Oregon
Port Clinton
Portage River
SANDUSKY BAY
SANDUSKY
Marblehead
Monroe
Wood Co.
Monroe Co.
Lucas Co.
Ottawa Co.
© Ohio Sea Grant College Program

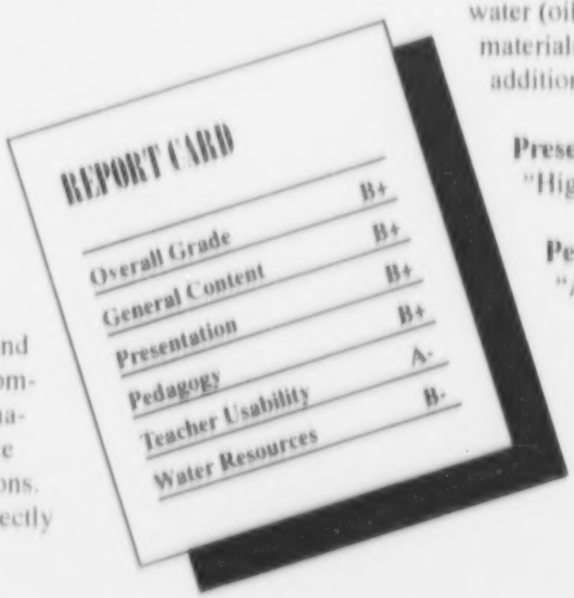
GRADES 10-12

Environmental Science Activities Kit

The Center for Applied Research in Education
Prentice Hall Order Processing Department
P.O. Box 11071
Des Moines, Iowa 50380-1071
(800) 288-4745

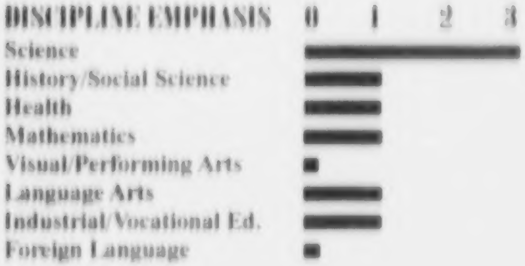
$29.95. 1993. 332 pages.

This resource book offers lesson plans, laboratory activities, and worksheets suitable for reproduction. Thirty-two activities are arranged in six units: Land Use Issues, Wildlife Issues, Water Issues, Atmospheric Issues, Energy Issues, and Human Issues. All activities are accompanied by teacher background information, specific procedures, reproducible materials, and recommended extensions. Three of thirty-two activities deal directly with water.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	B+
Teacher Usability	A-
Water Resources	B-



COMMENTS

General Content
A wide variety of topics are covered in this book; three focus on water (oil spills, water treatment, and conservation). "Curriculum materials include a broad spectrum of environmental issues in addition to water."

Presentation
"Highly organized."

Pedagogy
"Activities include individual action projects."

Teacher Usability
"Background information, and suggestions for both extensions and modifications are provided." "The teacher preparation section is extremely helpful."

Specific Content on Water Resources
The book emphasizes environmental issues and conservation ethics; few activities specifically deal with water.

ACTIVITY 12: "WATER" WE GOING TO DO?

Activity Summary

Students first guess how much water they think they use in their daily activities. Then they record their actual water use in a day. They learn that our water use at home is only a small part of the water used for each of us. Water wasted by a slow leak from a faucet is measured and extrapolated to show how much is wasted from a small leak over a period of a year. The students then learn some water conservation methods, including how to change a faucet washer.

Introduction

Water is an absolute necessity for life and for most of our industrial processes. The amount of water on Earth is finite, yet our demand keeps increasing as our population and industrial needs increase. Some investigators estimate that 30 to 50 percent of the water used in the United States is wasted. Many experts consider water conservation to be the quickest and cheapest way to increase our water supply.

One reason that so much water is wasted is that it is generally inexpensive. Federal and state funds are usually used to build dams and water-delivery systems to farms, industries, and communities. If the users had to pay directly for the costs of this water, they would waste much less. These subsidized water projects enable farmers to grow crops that demand lots of water, like cotton, alfalfa, and rice, in naturally dry areas such as Arizona and California. This artificially inexpensive water also enables farmers and industries to use wasteful methods and still make profits. Typical amounts of water use for various products is shown in Table 12-A on the student Background Information sheet (12.1).

Inexpensive water also fails to encourage water conservation at the home. People think little of a toilet that uses 6 or 7 gallons of water per flush even though 1.5-gallon-per-flush toilets are available. Lawns are often kept green and lush all year long in areas where there is no rainfall for much of the year. We wash our sidewalks and driveways with the most precious fluid on Earth! Table 12-C shows how we use water at home.

Most of us forget that the water that we use at our homes is only a fraction of the water use for which we are responsible. Water use in the United States is shown in table 12-B. It is important to realize that our purchasing habits determine what industry does. Driving cars for longer periods of time before replacing them, recycling aluminum, and saving energy all reduce water consumption by industry. Growing only crops for which the climate is suitable and adopting water-conserving agricultural practices could save huge amounts of water.

Another reason to conserve water is because the collection and movement of water have environmental effects. Damming rivers flood the valleys behind the reservoir. Canals and pipelines alter the environments through which they pass. Channelizing rivers destroys the natural riparian ecosystems. Diverting water from one area to supply another area is harmful to the ecosystems from which the water is taken.

Even if we have adequate water to meet our current domestic needs, we need to conserve water because shortages can occur at any time. It is predicted that many metropolitan areas of the United States, including those with adequate water supplies now, will have serious water shortages in the next ten years. Developing water-conserving habits today can help forestall the problem and make it easier to deal with when water shortages occur.

Name ______________________ Class ____________ Date ____________

12.2 "Water" We Going to Do?: Personal Water Use

Predicted Water Use

Your class has listed various ways that water is used in the home. Before actually recording how much water you use in a day and a week, record how much you think you use.

I think I use about __________ gallons per day and __________ gallons per week.

Actual Water Use

For the next 24 hours, keep track of the actual ways that you use water and the number of times you use water each way. You can use the estimated amounts per use or you can actually measure the amount of water used.

WATER USE	TIMES PER DAY	AMOUNT USED		TOTAL USED	
		estimated gallons*	measured gallons	per day	per week
bathing		30^{1}			
showering		50^{2}			
flushing toilet		6^{3}			
washing face/hands		5^{4}			
getting a drink		0.25^{5}			
brushing teeth		2^{6}			
cooking		10^{7}			
washing clothes		60^{8}			
washing dishes		30^{9}			
other					
TOTALS (should include things that don't happen every week):				______	______

*notes on estimates:
(1) depends on how full the tub is
(2) 25 gal with low-flow head
(3) 1.5 gal with water-saver toilet
(4) 2 gallons if you turn the water off
(5) includes running water to cool it
(6) 0.25 if you turn water off
(7) per supper, includes rinsing
(8) large load
(9) 10 gallons with dishwasher or if you use two 5-gallon pans

© 1993 by The Center for Applied Research in Education

Earth Matters

Zero Population Growth
1400 16th Street, N.W., Suite 320
Washington, D.C. 20036
(202) 332-2200

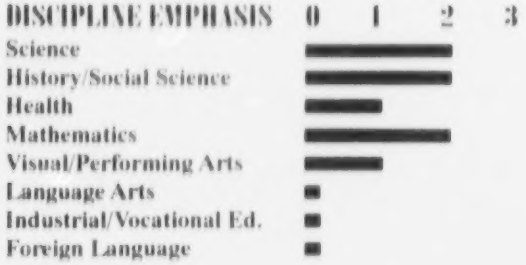
$19.95. 1991. 177 pages.

"Earth Matters" introduces interdisciplinary issues to secondary students through readings and corresponding activities. Twelve of 13 chapters address global issues including population dynamics, climate change, air pollution, water resources, deforestation, food and hunger, waste disposal, wildlife endangerment, energy issues, rich and poor, population and economics, and the world's women. The curriculum culminates with a final chapter dedicated to finding solutions through individual action.

REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B+
Pedagogy	A
Teacher Usability	B+
Water Resources	B

DISCIPLINE EMPHASIS



COMMENTS

General Content
A global environmental education curriculum. "The 'Eco-ethics' section stimulates higher level thinking and decision-making."

Presentation
Spiral bound format.

Pedagogy
"Activity-based lessons provide students with an opportunity to work in small groups and engage in role-playing." Student reading is required.

Teacher Usability
"Background data is very good. Labs have the potential to be excellent."

Specific Content on Water Resources
"Conflicting uses of water resources are addressed repeatedly through subtle prompts." Although "Earth Matters" is not designed as a water curriculum, some water issues are presented and examined in a global context.

424

425

Water, Water Everywhere

Student Activity 10

Concept: Although water covers three quarters of the Earth, only a small fraction is available for human consumption. As the population grows, water efficiency and conservation become more important.

Objective: Students observe a brief demonstration on the distribution of the world's water and then calculate how much water they use on a daily basis, both directly and indirectly.

Subjects: Biology, environmental science, math, family life.

Skills: Estimation, graphing, math calculation, observation, research, writing.

Materials:

7 clear containers
  (2 one liter containers, 5 smaller containers, one of which is plastic)
1 plate
Overhead projector
Masking tape
Marking pen
One liter of water
Salt (34 grams)
Sand (approximately 250 ml)
Blue food coloring
1000 ml graduated cylinder
One eye dropper
Graph paper
Calculators (optional)
Copies of Student Worksheet
Freezer

Procedure:

Part One:

Set-up:

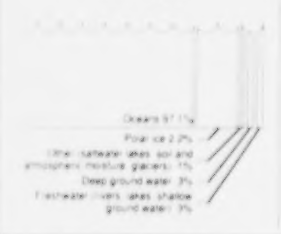
1. Gather all materials.
2. Fill one small container with sand.
3. Fill a one liter container with water, add four drops of blue food coloring and stir.
4. Label the other five containers as follows: a one liter container "oceans"; a small plastic container "polar ice"; a small container "deep groundwater"; a small container "fresh water."
5. Make a transparency of the adjacent diagram.
6. Measure and set aside 34 grams of salt.

Activity:

Perform the following class demonstration to help students visualize the distribution of the Earth's water resources.

1. Display the seven containers prepared for this activity.
2. Display a transparency of the figure on the right. Use a graduated cylinder to distribute the one liter of water into the five empty containers according to the percentages indicated in the figure. (For example, 97.1 percent of the water on the Earth is found in the oceans. Because one liter contains 1000 ml, 97.1 percent of one liter is 971 ml. Therefore, pour 971 ml into the container marked "oceans.")
3. After you have filled the empty containers with the appropriate amounts of water, continue with the demonstration as follows:
   a. Add 34 grams of salt to the "ocean" container; this will match the salinity of the water sample with the salinity of the Earth's oceans (3.5 percent).
   b. Place the plastic "polar ice" container in the freezer.
   c. Set the "other" container aside. We do not have access to this water.
   d. Pour the "deep groundwater" into the container of sand.
   e. Ask the students which of the containers represents fresh water that is readily available for human use. (They should easily see that only the jar marked "freshwater" has the readily available supply.) Initiate a discussion on the limits of fresh water supplies, the problems of population growth and distribution, and the contamination of existing supplies. Only a small part of this fresh water (.003 percent of the Earth's total water supply) is accessible. The rest is too remote (found in Amazon or Siberian rivers) to locate, too expensive to retrieve, or too polluted to use. Hold a plate in front of the class and dramatically drop the usable portion of fresh water onto it. (Represent this portion as one drop of water from an eye dropper.)

Distribution of the World's Water Supply



Adapted with permission from the National Science Foundation. The original activity appears in the National Science and Technology Week Activity Guide, 1988, by the National Science Foundation, Washington, DC.

Part Two:

1. Have students record how many gallons of water they think they use individually in an average day. Later, they will compare this estimated daily water use with their calculated daily water use.
2. As a group, have them list all the ways members of the class use water on a day-to-day basis.
3. Using the data in the table, "Domestic Uses of Water," have them determine their individual water use per day for each activity that the class listed in Step 2. They should include their share of general family uses such as dishwasher and clothes washer. Then they can determine their individual total water use per day.
4. Students should compare the individual water use calculated in Step 3 with the water use estimated in Step 1. Are their calculated figures higher or lower than their estimated figures? Ask students whether they consider themselves typical water users. Have them explain their answers.
5. Students should now draw a bar graph to illustrate how much water is used by their class for each activity. Which activities require the most water? Using the class average, students should also calculate the average use of their town and/or state.

Suggested Answers to Student Worksheet Questions:

1. Water is needed to grow the food and grasses the calf consumes, in addition to the water it drinks.
2. Student answers will vary.
3. Student answers will vary.
4. Possible answers: purchasing and eating foods which require less water to cultivate (eating lower on the food chain); recycling items to prevent excessive use of water in manufacturing; driving less.
5. Possible answers: take showers instead of baths; don't let water run while brushing teeth or shaving; fix leaky faucets; install water saving devices for toilet and shower; water lawn less frequently; run dishwasher and washing machine only when you have full loads.
6. Student answers will vary. For further information on water contamination, you may wish to contact the U.S. Environmental Protection Agency, Public Information Center, 401 M Street, SW, Washington, DC 20460, 202/260-2080.

Follow-up Activities:

1. Have students investigate new household products which conserve water (such as low flush toilets, new shower heads, timed sprinklers, etc.). Each student or group of students could be responsible for writing up a brief synopsis of the costs and benefits of one or two of these products. (Note: Free catalogs listing water conservation gadgets are available from: *Eco Source*, P.O. Box 1656, Sebastopol, CA 95473, 800/688-8345, and *Seventh Generation*, 49 Hercules Drive, Colchester, VT 05446, 800/441-2538.)
2. Have students read their home water meters daily for a week, at the same time each day, and report back to the class. They can then compare these readings to their estimates of daily water use. They can then read the meter for a second week, in which they implement many of the conservation measures suggested above.

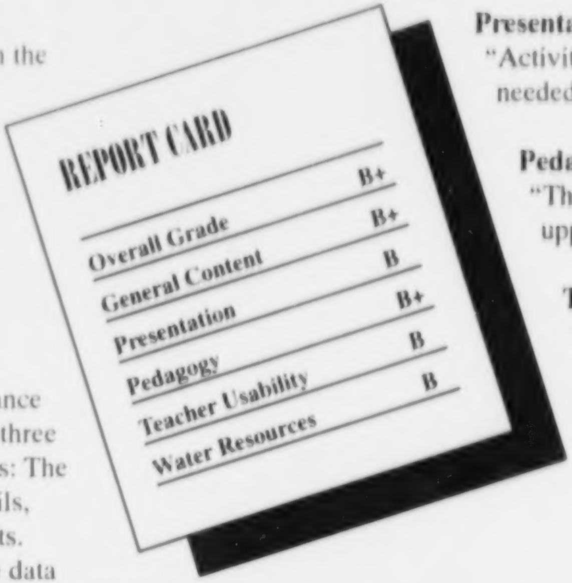
Adapted with permission from Biological Sciences Curriculum Study. The original activity appears in Biological Science: An Ecological Approach, BSCS Green Version (Kendall/Hunt Publishing Company, 1987).

Groundwater: A Vital Resource

Tennessee Valley Authority
Water Quality Department Library
1101 Market Street, 2C Haney Building
Chattanooga, Tennessee 37327
(423) 751-7338

Publication is no longer available from the Tennessee Valley Authority. Limited copies are available from the Department of Water Resources [(916) 653-1097] which has been granted permission to reprint the material for educational purposes only.

"Groundwater, A Vital Resource" (61 pages) focuses on the role and importance of groundwater and aquifers. Twenty-three activities are organized in four sections: The Water Cycle, Water Distribution in Soils, Water Quality, and Community Impacts. Background information, reproducible data sheets, groundwater maps, and a glossary are provided.



REPORT CARD

Overall Grade	B+
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	B
Water Resources	B

COMMENTS

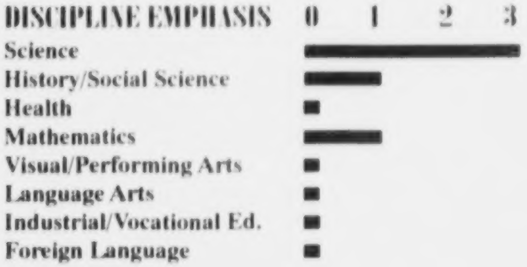
General Content
"Activities and concepts focus on groundwater and water quality.

Presentation
"Activities are well organized." "Additional graphics are needed."

Pedagogy
"The multi-level program does not consistently challenge upper levels."

Teacher Usability
"The short lessons could be beneficial or problematic for the teacher." Water quality test instructions are not always adequate. "Needs more background information."

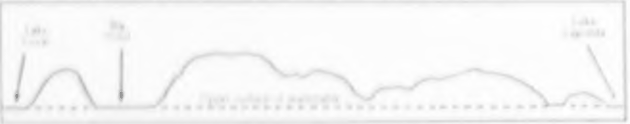
Specific Content on Water Resources
"A very good presentation on groundwater." Not a comprehensive treatment of water resources.



CALCULATING WATER TABLE DEPTH

PROCEDURE

1. Construct a profile map of the area marked XY on the topographic map



2. Connect lakes by dotted line; this indicates the water table.

FOLLOW-THROUGH (QUESTIONS)

1. What is the surface elevation (number of feet above sea level) at each of the 3 lakes taken from the topographic map?

Lake Loyal:	(100 ft.)
Big Pond:	(95 ft.)
Lake Lagonda:	(80 ft.)

2. In what general direction will the groundwater migrate in the area?

   (SE)

3. What is the average gradient of the water table surface in feet per mile?

   3/8 ft/mile

4. At $25.00 a foot, how much would it cost to drill a well to the water table from the top of the 184-foot peak east of Big Pond?

   (184 - 95) = 89' of drilling

   89' x $25.00/ft. = $2225.00

REFERENCE

Dallmeyer, R. D.: *Physical Geology: Laboratory Text and Manual*, Second Edition, 1978, Kendall/Hunt Publishing Co., pp. 195-198.

CALCULATING WATER TABLE DEPTH

GRADES 9-12

OBJECTIVE

Participants will relate the lake and stream elevations of a region to the variations of the water table depth.

MATERIALS

—topographic map
—ruler
—pencil, paper

PREPARATION

Participants should have been instructed in formation of topographic profile from line drawn along area of a topographic map.

1. Review: Read contour elevation on map
   Topographic profile preparation

2. Lecture:

   Precipitation migrates downward through soil and bedrock until all spaces are saturated. This lower level marks the upper surface of the local *water table*.

   The depth of the water table varies with local topographic irregularities, being slightly elevated under hills.

   As water within the saturated level above the water table migrates through the soil and bedrock, it follows gradients in the water table surface.

   When this slow-moving groundwater reaches an intersection of the water table with the land surface, a spring forms and the water is often added to a stream or lake.

   A topographical map may be used to determine local variations in the water table depth.

   A profile map along a given line is constructed, including lakes, streams, sinkholes, and/or other water/land intersections. A line is drawn on the profile connecting the different water bodies. *Each lake is a local record of the water table level.*

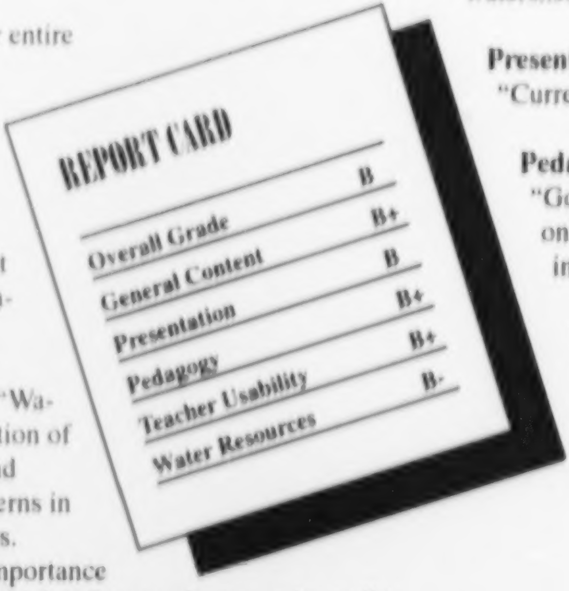
Teacher's Guide to World Resources

World Resources Institute
Publications
P.O. Box 4852, Hampden Station
Baltimore, Maryland 21211
(410) 516-6963

🌧 🌧 🌧

$49.95 (less 20% teacher discount) for entire set. 1994. Booklet format.

Two of eleven secondary level units, "Watershed Pollution (21 pages) and "Oceans and Coasts" (18 pages), present lessons that integrate global environmental and development issues. Teaching suggestions, presentation materials, student activities and handouts, and overhead transparency masters are provided in the booklets. "Watershed Pollution" focuses on the function of watersheds, water pollution sources and solutions, and water consumption patterns in industrialized and developing countries. "Oceans and Coasts" focuses on the importance of oceans to life, the human activites which influence them, marine pollution, global fisheries, and international marine pollution issues.



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	B+
Water Resources	B-

COMMENTS

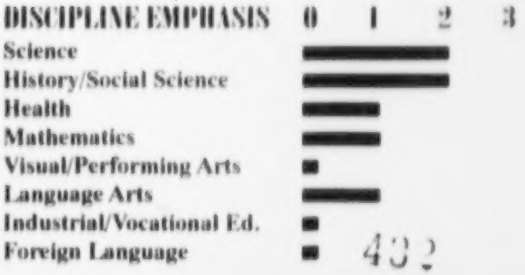
General Content
"Individual modules address specific issues such as oceans and watershed pollution."

Presentation
"Current statistics presented in overhead transparencies."

Pedagogy
"Good activities." "Activities are intended to be enrichment only and to be integrated into an existing curriculum." "An inquiry approach is used."

Teacher Usability
"Possibly more appropriate as supplemental material." "Useful, but in a limited application within biology or other core science course."

Specific Content in Water Resources
"Although narrow in scope, the information given is excellent." "Provides a global perspective of water resource problems."



432

433

Watershed Pollution

If you were asked to list things that move in the water, you might mention a crab scuttling abruptly sideways or a fish gliding away with a flick of the tail. Other things also move in the water; some are visible, such as a bobbing empty plastic bottle, a multi-colored oil slick, or a cloud of brown mud; others are invisible, such as disease-causing bacteria, toxic chemicals discarded by factories, or fertilizers from farms and suburban gardens.

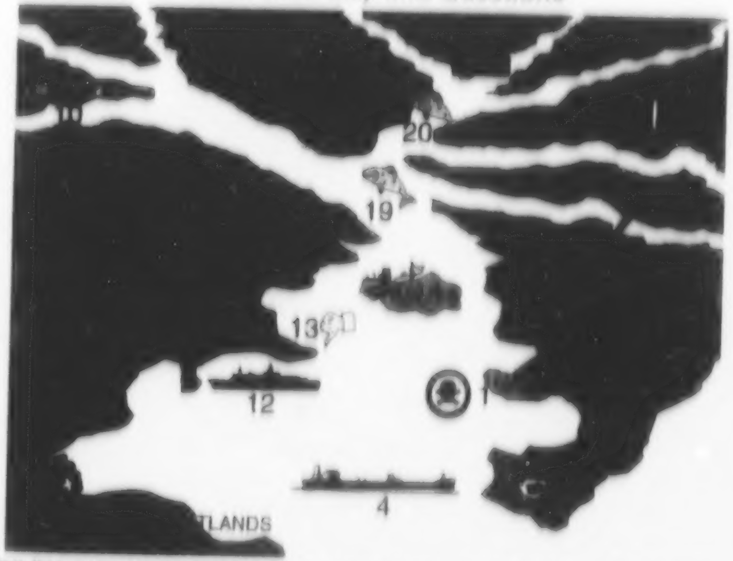
This lesson examines watershed pollution, a serious and growing problem. Most of the world's people live along rivers and in coastal areas. Water is essential for their life and for the basic activities that sustain them. The lesson begins by defining a watershed and introducing the process by which pollutants enter and travel along streams, rivers, and lakes to coastal areas. Using an inquiry exercise, students investigate events that affect the health of an imaginary watershed. The lesson then compares water use and water pollution in industrialized and developing countries and analyzes the causes and costs of water pollution. Finally, it takes a look at strategies to deal with watershed pollution and asks students to identify steps they and their families can take.

Objectives

By the time they finish this lesson, students should be able to:

- Define watershed.
- Describe how different kinds of pollutants enter the water and move through the watershed toward coastal areas.
- List ways in which humans use water and describe how pollution can both be affected by and affect these uses.
- List types of pollutants and describe their effects on humans and aquatic life.
- Identify steps at the local, national, regional, and global levels that can help reduce water pollution and evaluate each in terms of its potential positive and negative effects.
- Compare and contrast water consumption patterns in industrialized and developing countries.
- Identify actions that students and their families can take to conserve water and reduce water pollution, and evaluate each in terms of its potential positive and negative effects.

Watershed Map and Questions



Note: This is not a map of an actual watershed but represents an area where the events used in this exercise could take place. The events selected for this exercise have all actually occurred, but in various locations, not in a single area.

Questions about Watershed Map and Events

Part I. Answer these questions for each event.

1. What area of the watershed is likely to be affected by this event?
2. Is this event likely to improve or hurt water quality? Why?
3. Are the effects of this event likely to be short term? Long term? Both?

Record your answers on a separate piece of paper, using the following format:

Event No.	Area Affected	Effect on Water Quality
1.		

Part II. Summary Questions

How many different kinds of pollution are entering the water?
How many different sources of pollution can you identify?
Which instances of water pollution are accidental?
Which events might have the most effect on the watershed?
How might upstream events affect downstream users?
Which upstream events affect downstream environments?
What must be done to protect water quality at the wetlands? At the swimming beach?

GRADES 10-12

BEST COPY AVAILABLE

A Curriculum Activities Guide to Water Pollution and Environmental Studies

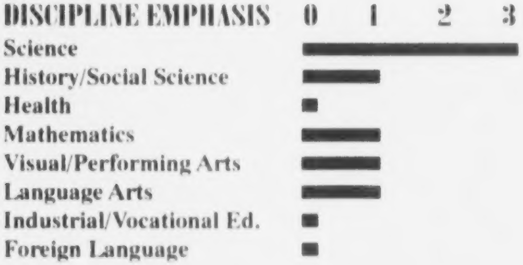
Chadbourne & Chadbourne, Inc.
18554 Haskins Road
Chagrin Falls, Ohio 44023-1823
(216) 543-7303

$18.00 and $3.00 shipping per volume. 1970. Volume I (217 pages), Volume II (252 pages), Volume III (114 pages).

Three volumes combine to present a comprehensive water pollution curriculum. Volume I focuses on the hydrologic cycle, human activities, ecological perspectives, and sociopolitical factors. Volume II offers technical guidance regarding water quality parameters (chemistry, bacteriology, aquatic biology, and engineering/physics). Volume III is a guide to constructing water quality equipment and conducting water quality tests.

REPORT CARD

Overall Grade	B-
General Content	B+
Presentation	B-
Pedagogy	B+
Teacher Usability	B-
Water Resources	B+



COMMENTS

General Content
"A wide variety of activities are based on four major themes." "An in-depth 'nuts and bolts' guide to water studies in the field."

Presentation
"The direct and simple (but elegant) style of presentation will be appreciated."

Pedagogy
"Offers several, hands on labs." "Grade level appropriate for grades 11 - 12."

Teacher Usability
"Some of the information is dated (1970's)." "Lacks student-ready materials." "Requires a great deal of prior background knowledge and current interest by the teacher." Chemicals used in the laboratory tests may require special handling and disposal.

Specific Content on Water Resources
Thorough coverage of water pollution issues.

436

437

M. The Water Budget of a Small Watershed

I. Introduction

The purpose of this activity is to introduce the student to the hydrologic and nutrient cycle budgets of a small watershed. It is an advanced-level study and is best attempted by the student who has completed a number of the hydrologic cycle activities.

II. Questions

1. To lead into activity:
   a. If we outline any particular area of land, what are the mechanisms by which water enters that area?
   b. What are the mechanisms by which it leaves the area?
   c. What changes are seen in the form of water while it is in the area?
2. To initiate the activity:
   a. On a particular area of land, what is the total yearly input of water?
   b. What is the total yearly output of water?
   c. By what mechanisms does water enter and leave the area?
3. To continue the activity:
   a. Within the particular area, what nutrients enter and leave using the hydrologic cycle as a vehicle?
   b. What physical and biological characteristics of the system affect the amount of water and nutrients flowing through it?
   c. Is it possible to calculate a nutrient and water budget for the area of study?
4. To evaluate the student's performance consider:
   a. Although it will be unusual to have calculated a balanced watershed budget, does the student display an understanding of such a budget?

   b. Did the student realize that the input minus the output equals the change in storage within the system?
   c. Were the techniques and references used by the student to calculate input and output reasonable and successful?
   d. Did he realize that a long term study is essential for an accurate calculation of a hydrologic or nutrient budget?
   e. Was he aware of the discrepancies involved in such an activity and did he attempt to explain them?

III. Equipment

1. References of climatological and hydrological data for the area of study
2. Equipment for measurement and testing of precipitation, transpiration, evaporation, and flow which has been outlined in previous activities and which depends on the number of parameters the student chooses to study within the particular area
3. Topographic maps and long-distance measuring devices

IV. Procedures

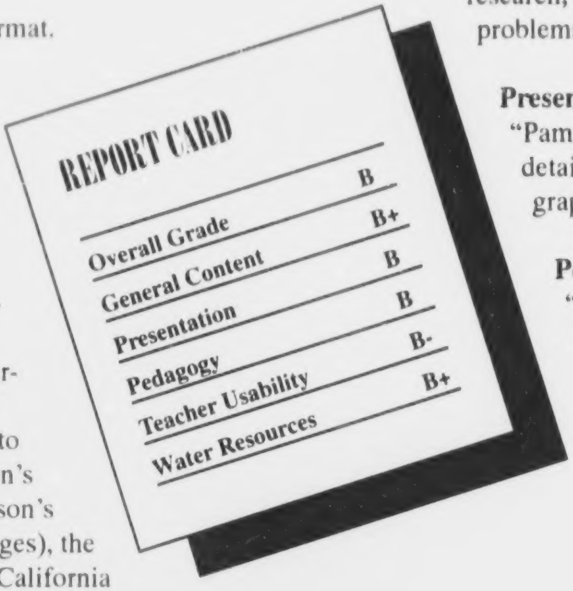
1. Have the student delineate an area for study.
2. Have the student calculate the area of his system.
3. Have the student calculate the yearly precipitation input.
4. Have the student identify and measure other system inputs.
5. Have student identify and measure other system outputs.
6. Using extrapolation techniques and his own and reference data, if available, have the student calculate the hydrologic budget for the area.
7. Have the student collect samples of water from various inputs (e.g., precipitation) and outputs (e.g., outflow).
8. Have students chemically analyze the water quality for nutrients.
9. Using extrapolation techniques and his own and reference data, if available, have the student calculate the nutrient budget of the area.

California's Water Problems

Water Education Foundation
717 K Street, Suite 517
Sacramento, California 95814
(916) 444-6240

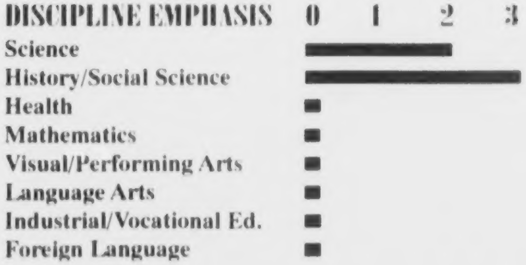
$20.00. Revised in 1996. Package format.

"California Water Problems" offers four role-playing scenarios based on water management case studies: the Delta Dilemma, the Kesterson Clean-Up, the Colorado River Cut-Back, and Groundwater Worries. Students are given the opportunity to develop research skills and participate in cooperative learning exercises. Materials include the Teacher's Guide (60 pages), Layperson's Guide to California Water (24 pages), Layperson's Guide to the Delta (20 pages), Layperson's Guide to Agricultural Drainage (16 pages), the California's Water System poster, the California Water Map, and the Colorado River Water Map.



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B
Teacher Usability	B-
Water Resources	B+



COMMENTS

General Content

"Three scenarios are presented that engage students in role-playing, research, presentation, and critical thinking about specific water problems in California."

Presentation

"Pamphlets are very appropriate for grades 10 - 12." "Nicely detailed information and pleasingly packaged." "Good graphics on the water maps."

Pedagogy

"Good social science material." "Scenarios involve real-life California issues."

Teacher Usability

"May prove difficult for a teacher to integrate into an existing program. Lots of information with a few questions, but no overview or theme to connect it all." "This could be used as supplementary material."

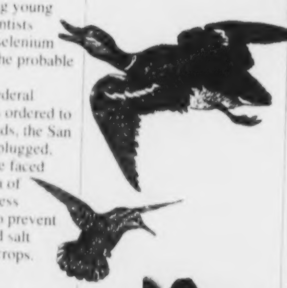
Specific Content on Water Resources

"Good source of information concerning agriculture and water; a great historical view of water in California."

THE KESTERSON CLEAN-UP

As drainage water collected underground, many minerals including an element called selenium were concentrated. Selenium is necessary for life, but only in tiny amounts. Larger concentrations of selenium are poisonous. This contaminated drainage water eventually flowed through the San Luis Drain to the Kesterson National Wildlife Refuge, where it settled in marshy ponds. In 1982, the U.S. Fish and Wildlife Service discovered unusually high concentrations of selenium in fish at Kesterson, and in 1983 and 1984 they found an alarming incidence of deformity and death among young waterfowl. Scientists concluded that selenium poisoning was the probable cause.

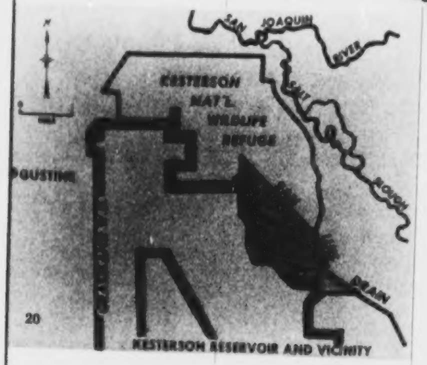
In 1985 the federal government was ordered to clean up the ponds, the San Luis Drain was plugged, and farmers were faced with the problem of dealing with excess drainage water to prevent waterlogging and salt damage to their crops.



THE PLAYERS

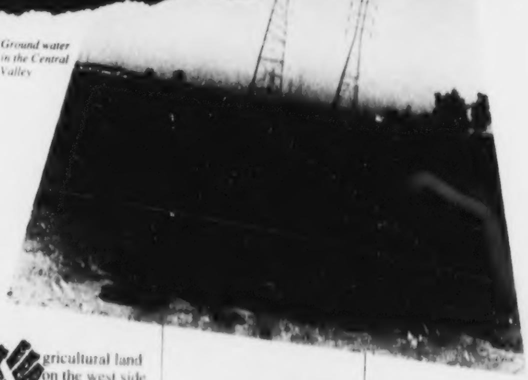
1. **Chairman of the State Water Resources Control Board**
2. **Hydrologist for the Bureau of Reclamation**
3. **Attorney for the Environmental Defense Fund**
4. **Director of the Board of Westlands Water District**
5. **Head of the Fresno County Farm Bureau**
6. **U.S. Fish and Wildlife Service biologist**
7. **Land owner/farmer of land adjacent to Kesterson**
8. **Scientist, University of California's Salinity/Drainage Task Force**

AREA
CLOSED


SAN JOAQUIN RIVER
SALT SLOUGH
KESTERSON NAT'L WILDLIFE REFUGE
GUSTINE
DRAIN
20
KESTERSON RESERVOIR AND VICINITY

PART II - THE KESTERSON CLEAN-UP

Ground water in the Central Valley



OBJECTIVES

Students will be able to:

1. **Explain how salts and minerals get into the water supply and how a build-up of their concentrations affects the environment.**
2. **State the relationship of ground water to surface water.**
3. **Describe how agricultural drainage water collects and harms crops, and the need for a disposal plan.**

Agricultural land on the west side of the San Joaquin Valley contains many salts, minerals, and small quantities of elements, such as selenium. "Salts" are a group of chemicals with certain characteristics. Table salt, sodium chloride, is one example. Large parts of this area also have impermeable layers of clay which stop the downward movement of water when the land is irrigated. This can result in salty ground water building up beneath the surface and eventually rising into the root zone of the crops. Two problems are therefore created for farmers. Without adequate drainage, a field can become waterlogged, like a flowerpot without a hole, stunting plant growth and reducing agricultural productivity. Also, while minerals are beneficial in small amounts, most plants can only stand limited amounts of them, so water beyond that required to meet the crop's needs is applied to saline (salty) soil to wash, or leach, excess salts from the root zone.

So farmers must drain water from their lands so they don't become waterlogged and also remove excess water used to leach out excess salts and minerals. They put pipes with holes in them under the surface of their lands to collect and drain away this excess agricultural water. The federal government began to build the San Luis Drain in 1968 to remove the drainage water, but some people were concerned about what would happen to the Sacramento/San Francisco Bay and Delta if the water was discharged there. As a result, the Drain was never completed and instead the water was drained into the Kesterson Reservoir, which was to be used jointly for irrigation drainage and wildlife habitat.

(Continued)

GRADES 10-12

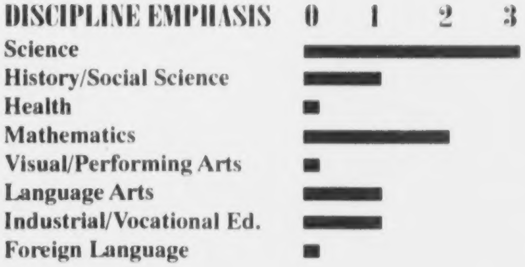
The Fluid Earth

Hawaii Marine Science Studies
Curriculum Research and Development Group
1776 University Avenue
Honolulu, Hawaii 96822
(800) 799-8111

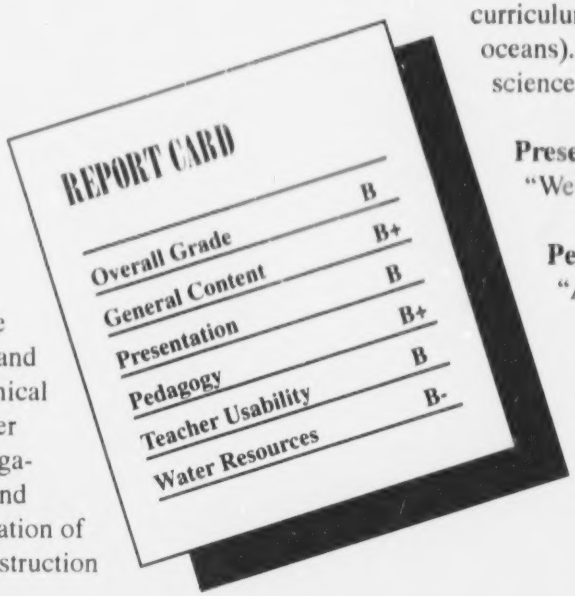
$148.95. 1993. Three books.

Textbook (386 pages), Workbook Masters (76 pages), and Teacher's Guide (278 pages) combine to explore the physics, chemistry, and geology of the oceans through a multidisciplinary science course. Five units, (earth and ocean basins, waves and beaches, physical oceanography, chemical oceanography, and transportation) offer sequential laboratory and field investigations. Appendices include materials and equipment list, suggestions for preparation of solutions, instructional aids, station instruction cards, and laboratory and field safety instructions.

DISCIPLINE EMPHASIS



🌧 🌧 🌧



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	B
Water Resources	B-

COMMENTS

General Content

"Unique material for physical oceanography." "One of a two part curriculum (the other focuses on the biological aspects of the oceans)." "Strongly developed ...a thorough job on the marine sciences and related aspects of water resources."

Presentation

"Well organized with specific teacher/student directions."

Pedagogy

"A very hands-on approach."

Teacher Usability

"If a teacher wants to use this for oceanography or adapt it to a freshwater environment, it is one of the best resources for the integration of physics that I have ever seen." "Some activities require an ocean field trip."

Specific Content on Water Resources

"This is a Hawaii curriculum which focuses on the oceans. Consequently, it does not address many issues that we in California face in dealing with water." Looks at water in general, but not in relation to the environment or living organisms.

Topic 5. Water, Energy, and the Water Cycle
(FE 272)

Focus
Energy and the water molecule; temperature-phase (ice, liquid, steam) relationships; evaporation, condensation, precipitation, and specific heat; distillation; fresh water on earth; global water cycle

Purposes
1. Observe and explain the freezing and melting of ice.
2. Relate energy (temperature) to changes in the behavior of the water molecule.
3. Explain water's three states (ice, liquid, steam).
4. Distill fresh water.
5. Explain the still in terms of evaporation and condensation.
6. Relate the still to the distribution of fresh water on earth.
7. Describe the global water cycle.

Background and Introduction
This topic explores the effects of temperature changes on water. Freezing and melting are presented with reference to the structure of the water molecule and the attraction between dipolar, asymmetrical molecules. At the chemical level, students understand how water forms ice and melts, evaporates at room temperature, and boils and condenses—all with reference to how energy affects the movement of water molecules. At a concrete, physical level, they investigate the properties of frozen and melting ice and set up a distillation apparatus that evaporates water at temperatures lower than boiling. They then apply their understanding of the behavior of water with temperature changes to global understanding of the water cycle and the global distribution of water.

Organization
Divide the class into teams to carry out Activity 1. Set up Activity 2 as a class demonstration to be carried out while reading pages FE 277–279 and discussing the heating and cooling graphs in Figs. 5–4 and 5–5. Allow four days for the entire topic.

ACTIVITY 1 (FE 273, W 64)
Investigate the properties of freshwater and saltwater ice.

MATERIALS
Per station (to prepare salt water in Procedure 1)
___ table salt
___ centigram balance
___ 1,000-mL beaker
___ stirring rod

For the class to share:
___ masking tape
___ waterproof marking pen
___ freezer
___ ice pick or screw driver
___ hammer

Per team of students:
___ two 1-qt milk cartons
___ scalpel
___ 100-mL graduated cylinder
___ fresh water
___ centimeter ruler
___ pencil (or use waterproof markers or labeled pieces of masking tape)
___ newspapers
___ rubber bands
___ scissors
___ marking pens or labels
___ three 250-mL beakers
___ heat source
___ stirring rod
___ thermometer
___ hydrometer
___ paper towels
___ plastic spoons (optional)

PROCEDURE NOTES

2. a. The waxy coating on most cartons makes it hard to label them with a marker. You can use a pencil, an indelible marker, or a labeled piece of masking tape. All that's needed is to be able to distinguish the saltwater carton from the freshwater carton. Tell students to put their team number or their initials on the cartons.

2. b. Since most classes do not have enough 1,000-mL graduated cylinders, students will have to use their 100-mL graduated cylinders to measure 900 mL of seawater. Alternatively, several quart jars (mayonnaise jars) could be marked in advance of the experiment at the 900-mL level.

2. c. Remind students to measure accurately.

2. d. Tell students to label the newspaper with their team number or their intials. Students may not know that newspapers provide good insulation. Wrapping minimizes the tendency of the water in the carton to freeze from its outer walls in. You can set up cartons without the newspaper insulation as a comparison.

3. Results will vary, depending on conditions during freezing. Fresh water freezes clear and solid and breaks into large chunks. The salt water may not freeze completely, leaving very salty brine at the top. Frozen salt water is not clear; it breaks into flat, layered pieces.

4. b–d. Set up a station with an ice pick or a hammer and extra newspapers where students can break up their ice blocks. Place the separated blocks

Table T5–1. Height of liquids and ice in cartons (Sample data) (FE 274, W 64)

	Height (cm)	
	Salt water	Fresh water
Start (liquid)	16.7 cm	16.7 cm
Finish (ice)	17.5 cm	18.0 cm
Change	+ .8 cm	+1.3 cm

* 900 ml = starting volume, both samples

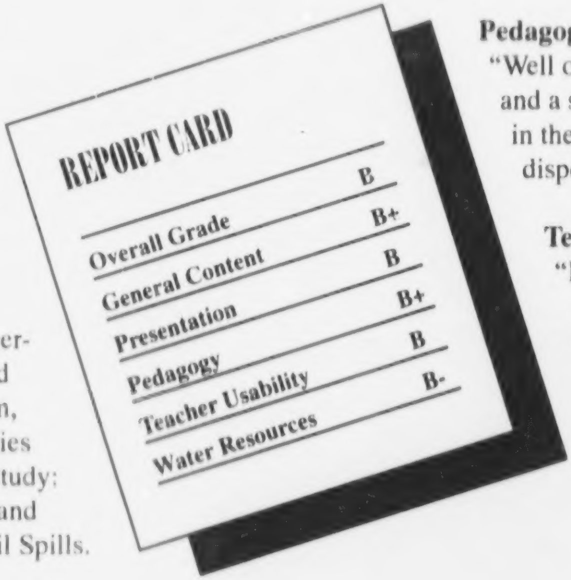
Hands-On Environmental Science Activities

Alpha Publishing Company, Inc.
1910 Hidden Point Road
P.O. Box 6636
Annapolis, Maryland 21401
(410) 757-5404

🌧 🌧 🌧

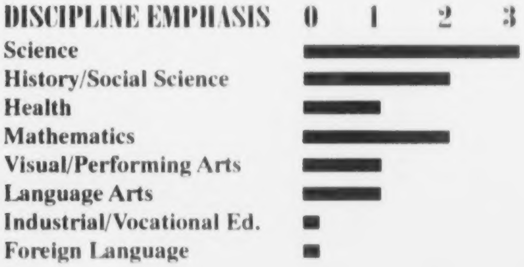
$45.00. 1992. 260 pages.

The Teacher's Edition, together with the Laboratory Manual for "Hands-On Environmental Science Activities," offer enrichment activities in environmental science. Eight units present forty activities in the following areas: ecology, energy, conservation of Earth's resources, human and animal populations, pollution, activism, politics, and economics. Water activities include Water Consumption, A Case Study: the Ogallala Aquifer, Water Pollution and Water Plants, Water Treatment, and Oil Spills.



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	B
Water Resources	B-



COMMENTS

General Content
A good source of varied activities.

Pedagogy
"Well organized, self-contained lessons; enrichment activities and a section on social action are provided." The bacteria used in the simulated oil spill clean-up require safe handling and disposal. "Activities are too simple for advanced students."

Teacher Usability
"Little background information is offered."

Specific Content on Water Resources
One section deals with water resources.

WATER TREATMENT

INTRODUCTION: Water **pollution** affects everyone. It affects our health. Much of it is **toxic**, damaging life in rivers, lakes and oceans. So how can polluted water be treated? You will investigate that concern in this activity.

PURPOSE:

- How can polluted water be treated?

MATERIALS:

Each group will need:

liter jar with sample sewage prepared by the teacher

empty liter jar
activated charcoal
filter paper
goggles

strainer
large test tube
test tube stopper
lab apron

Optional *Chemical Pollution Test Kit*

PROCEDURE:

Background: Much polluted water is sewage. Sewage treatment generally occurs in three stages. The first, **primary treatment**, is mostly mechanical. The next, or **secondary treatment**, is mostly biological. The last, or **tertiary treatment,** is mostly chemical. Unfortunately, all three are not always used, and of course, the more types of treatment, the better the cleaning.

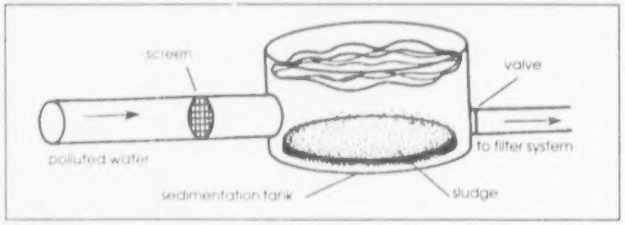


Illustration 19-1

© 1991 ALPHA PUBLISHING COMPANY, INC

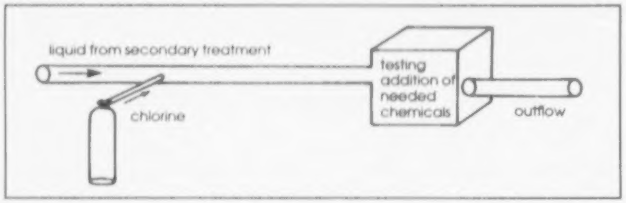


Illustration 19-3

1. **Put on your goggles and lab apron.**
2. Observe the polluted water. How clear is it? Does it have an odor? What else can you say about it? Record your observations.
3. Place the strainer over the empty liter jar. Slowly and carefully pour all of the prepared sewage through this filter. Record your observations.
4. Allow the jar to stand for a day. This is your sedimentation tank. Record your observations.
5. Place the activated charcoal in the strainer. In a sink, wash the charcoal until particles do not come out. Place enough charcoal in a test tube so that it is about $^1/_4$ full. Place a piece of filter paper over the test tube. Carefully and slowly pour about $^1/_2$ test tube of the strained sewage liquid into the test tube. Stopper the tube and gently shake it for about half a minute. Observe the water. Shake again. Record your observations.
6. If you are using the optional water test kit, follow your teachers instructions and record your observations.

OBSERVATIONS:

1. Describe the "sewage" water that you received.

____

____

____

____

2. What was the effect of straining?

____

____

____

© 1991 ALPHA PUBLISHING COMPANY, INC

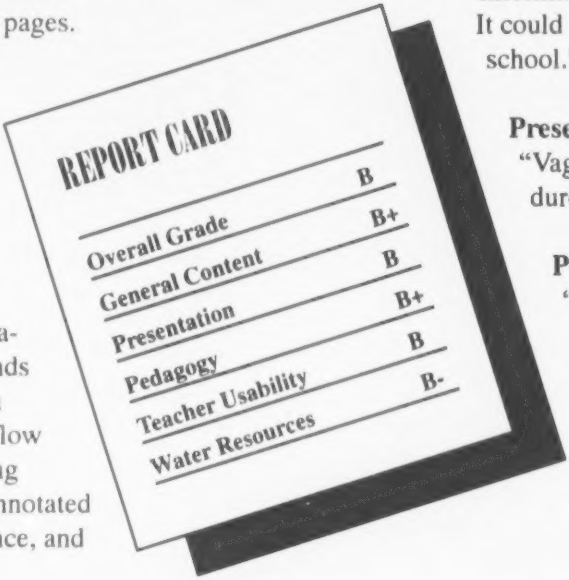
GRADES 10-12

A Curriculum Activities Guide to Watershed Investigations and Environmental Studies

Chadbourne & Chadbourne, Inc.
18554 Haskins Road
Chagrin Falls, Ohio 44023-1823
(216) 543-7303

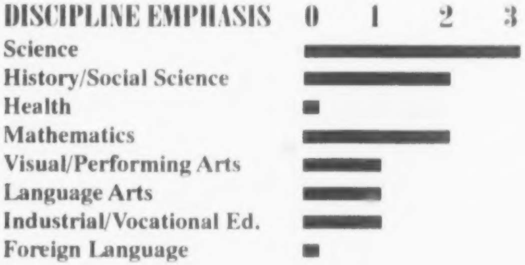
$18.00 and $3.00 shipping. 1995. 143 pages.

"A Curriculum Activities Guide to Watershed Investigations and Environmental Studies" is organized according to three broad sections: an overview of watersheds, teaching resources and activities, and operational and technical skills. Student activities invite a study of headwaters, groundwater, steep slopes, wetlands and flood plains, soil mapping, human impact, community planning, stream flow measurements, and community meeting preparation. Appendices include an annotated bibliography, an agenda for a conference, and sample minutes and program plans.



REPORT CARD

Overall Grade	B
General Content	B+
Presentation	B
Pedagogy	B+
Teacher Usability	B
Water Resources	B-



COMMENTS

General Content
"A comprehensive watershed project which is cross-curricular." "Information is a 'nuts and bolts' guide to a community project. It could serve as a central theme for a small cluster or the entire school." "This is 'idea-rich'!"

Presentation
"Vague in the presentation of activities (few specific procedures are provided)."

Pedagogy
"Not truly a stand-alone watershed study package."

Teacher Usability
"Activities require a watershed environment." "Very involved - teachers will have to take time to read and sort out a plan for their curriculum."

Specific Content on Water Resources
"A very thorough narrative on watershed studies."

What Can You Do in an Urban Area Watershed?

A great deal of water pollution comes from man's activities in urban centers. Most of this polluted water runs off into the storm drain and surfaces many miles away in a stream or lake. Storm drains are to the city what streams are to suburban and rural areas—the plumbing system for the land. Toilets, sinks, and storm drains, are sometimes thought of as "magic holes". Once waste goes down it, you don't have to worry about it. It becomes a public problem.

Many fascinating comparative studies can be designed to determine how city air and land use determine water quality. Among them:

Activity #1: **Is rain water polluted?** Compare the pH, nitrate, and sulfate levels in rain water, distilled water, and distilled water run through an air filter. Collect rain water running off buildings and compare it with rain water falling directly to the ground, again using distilled water as a control.

Activity #2: **What is the distribution of air pollutants in the city?** Designate students who live in different parts of town to put jars out in their backyard or on their roof, collect rainwater, and to bring it to the next class to be analyzed for pH, nitrate, and sulfate. Plot the results on the map. Arrange with schools in the suburbs to do the same thing and compare results.

Activity #3: **Define the watershed of a single storm drain.** This can be done best during the rain, so that you can determine precisely where the water is coming from that goes into the drain. Students might also fabricate some kind of sighting level to determine the topography, if rains are infrequent. Prepare a questionnaire for residents in the area to determine how their actions influence water quality. Questions should include:

- How many pets do you have?
- What happens to their feces and urine?
- Do you wash your car in your yard? how often? what products do you use for washing?
- Do you have a garden? What fertilizers do you use?
- Do you change the oil in your car yourself at home? What happens to the old oil?

Determine if you can detect any of these human activities in runoff water.

Activity #4: **What effect do stray dogs have on water quality?**

Equipment: Storm sewer map, topographic maps, sanitary sewer maps, Hach kit, questionnaires, Millipore apparatus for testing coliform bacteria.

One Possible Procedure:

a. Divide the class into committees to investigate the several areas of town.

b. Select streets throughout town in varying districts. Choose dirty streets with over-turned garbage cans, clean streets, streets in towns with stiff dog laws, very well kept streets with lots of pet dogs penned up, well kept streets with few animals, streets in business districts, etc.

c. During or immediately following a storm, take water samples in ditches leading into storm drains. Take water samples in sterile bottles. Determine counts of fecal coliform and fecal streptococcus bacteria.

d. Analyze the bacteria count. Construct a water quality map. Determine causes of the differences. Plan a community education program in areas where personal habits can be changed to improve water quality. Work with street clubs, media representatives, etc.

The Impact of Specific Land Uses on Water Quality

Certain specific activities that go on within the watershed can have considerable impact on environmental quality in the vicinity of the activity or land use. Three examples that lend themselves to student investigations are presented here.

1. **What to Do with Industry?**

Industries are often earmarked as the primary polluters, fairly or unfairly. Before you draw any conclusions about them, study their manufacturing technology.[22] Get to know the people in the company. Find out what problems they have with competition, waste disposal, pricing, etc. Are the explanations they give you excuses or are they reasonable? What alternatives are available to deal with their problems? What are they doing now? Which are the best alternatives, considering future growth plans for the watershed?

2. **What You Can Do with a Golf Course within Your Watershed**

The problem during the spring and summer is that runoff from heavy fertilization of golf course grass often increases the hardness, alkalinity, and nitrate levels of downstream water. Grass clippings left on stream banks may wash in, creating at times a higher than normal organic load, a correspondingly high bacterial level, and depressed dissolved oxygen concentration.[23] However, the forest which preceded the golf course contributed its leaves to the stream. Does the grass equal that load or *exceed* it?

---

[22] More about the topic of industrial waste generation and proper disposal can be found in the volume, *Pollution Prevention Strategic Decisions for the '90s*, referred on the back of this volume's title page.

[23] See Volumes I and II, *A Curriculum Activities Guide to Water Pollution and Environmental Studies* referenced on the back of the title page of this volume.

Overview

Environmental Education Curriculum and Compendium Project

During the last twenty years, a vast number of environmental education materials have been developed in the United States for the K-12 classroom. Produced by a variety of individuals, agencies, and institutions, these curricula are of varying quality and value to the classroom teacher. For teachers, to select and implement suitable curricula is, at best, a demanding, complex, and challenging process. To facilitate and encourage the implementation of high quality curricula, the Office of Environmental Education within the California Department of Education (CDE) instituted the Curricula and Compendia Project. A project advisory group, made up of representatives from a number of state agencies and offices, established the following project tasks: (1) collect curricula through nation-wide searches; (2) evaluate the quality of curricula using an appropriate assessment instrument; (3) publish the results of the evaluations in topic-specific compendia that use a descriptive, ranking format; and (4) develop and implement strategies for distribution of the publications to educators across California.

To make this curriculum review manageable, seven topic areas were logically delineated: Energy Resources, Water Resources, Integrated Waste Management, Air Quality, Human Communities, Plant and Animal Communities, and Terrestrial and Aquatic Habitats (the latter two were later combined to form Natural Communities). The Energy Resources and Water Resources compendia were published in 1992, and the Integrated Waste Management compendium was published in 1993. The Air Quality and Human Communities compendia were published in 1994, and the Natural Communities compendium was published in 1995. The Energy Resources and Water Resources compendia have both been entirely redone in 1996.

The evaluation phase of the Curricula and Compendia Project utilizes four strategies: (1) development of a "Unifying Concepts of Environment Education" matrix by the CDE to serve as a cornerstone linking the project's six topics; (2) formation of an advisory group of experts for each project to create a topical "Conceptual Matrix" that aligns to the Unifying Concepts; (3) elaboration of topic-specific curriculum evaluation questions that are directly correlated to the "Conceptual Matrix"; and (4) systematic evaluation and ranking of environmental education curricula. When considered together, the conceptual matrices for the six compendia provide an extensive, yet cohesive, foundation upon which curriculum writers, environmental educators, and school administrators can base further instructional materials development in environmental education.

Conceptual Matrices for Environmental Education

Both the "Unifying Concepts of Environmental Education" and the "Conceptual Matrix for Water Resources" illustrated on the following pages are based upon the CDE environmental education philosophy described in the policy paper, "Point of View on Environmental Education" (1990). The "Unifying Concepts of Environmental Education" serve to provide a conceptual foundation for defining the boundaries of all environmental education. On the "X" axis are found three content descriptors: "The Natural Environment," "The Built Environment," and "The Personal Environment." On the "Y" axis are three process skills that encompass the full range of cognitive and affective change: "Fostering Awareness," "Understanding Concepts," and "Taking Action."

In the conceptual matrix for this compendium, the nine core concepts identified define the boundaries of, and expectations for, water resources curricula. Because environmental education is an interdisciplinary subject, the basic concepts of water resources correspond, to some degree, to all of the frameworks for California public schools and reflect the philosophy of the California Education Code. Framework correlations have been documented on page 223.

456

457

Unifying Concepts of Environmental Education

CONTENT PROCESS	**NATURAL ENVIRONMENT** Natural Systems and Interactions	**BUILT ENVIRONMENT** Human Alterations to Natural Systems	**PERSONAL ENVIRONMENT** Citizens' Roles, Responsibilities, Choices, and Actions
FOSTERING AWARENESS AND APPRECIATION OF THE ENVIRONMENT	Environmentally aware citizens cultivate in themselves and others a deep appreciation for natural systems and personal interactions with the natural environment.	Members of sustainable human communities value the natural environment and recognize humankind's ultimate dependence upon renewable and non-renewable resources.	An individual's quality of life and attitude toward the environment depend upon the distribution and quality of natural resources, which may be regulated by laws and influenced by local interests, cultural values, political climate, and international relations.
UNDERSTANDING BASIC ENVIRONMENTAL CONCEPTS	Individuals understand the relationship between the living and non-living components of natural systems.	Humans understand how they alter the natural and built environments. As human populations increase, their impacts on the global environment are more pronounced.	Individuals, communities, and societies understand and honor the symbiotic relationship between the natural and built environments such that a sustainable global community is created.
TAKING RESPONSIBLE ACTIONS TOWARD THE ENVIRONMENT	Individuals take appropriate, knowledgeable actions to restore, preserve, and protect the integrity of natural systems and interactions.	Members of sustainable human communities learn from past experiences, acknowledge human limitations, anticipate changes, and develop innovative systems to conserve resources and promote the vitality of both the natural and built environments.	Informed citizens influence the development of a sustainable global community through individual and collective actions, civic and organizational responsiveness, lifestyle choices, cultural sensitivity, career selection, regulatory and statutory processes, and economic practices.

Conceptual Matrix for Water Resources

CONTENT PROCESS	**NATURAL ENVIRONMENT** Natural Systems and Interactions	**BUILT ENVIRONMENT** Human Alterations to Natural Systems	**PERSONAL ENVIRONMENT** Citizens' Roles, Responsibilities, Choices, and Actions
FOSTERING AWARENESS AND APPRECIATION OF THE ENVIRONMENT	Individuals recognize that water is necessary for life and that a dynamic relationship exists between water and the physical and biological environments.	Individuals recognize the dependence of human communities upon reliable sources of clean water provided through complex water supply systems. They appreciate that there is a balance between the water needs of humans and those of other organisms.	Individuals are aware of their responsibility to conserve water and appreciate the limited supply of fresh water on earth. They recognize that human lifestyles are affected by the distribution, quality, and quantity of water available.
UNDERSTANDING BASIC ENVIRONMENTAL CONCEPTS	Individuals understand the properties of and interactions between water, climate, geologic formations, and the hydrologic cycle.	Individuals understand that water supplies can be managed in a sustainable way to satisfy residential, agricultural, industrial, and recreational needs. They know the sources of local water supplies and understand that groundwater, surface water, and reclaimed water can be distributed through a variety of water management methods and technologies with both positive and negative consequences.	Individuals understand the relationship between personal behavior and the quality and quantity of water in both the natural and built environments. They understand the importance of leading a lifestyle that provides for a sustainable use of natural resources.
TAKING RESPONSIBLE ACTIONS TOWARD THE ENVIRONMENT	In order to protect the health of the natural environment, individuals and organizations monitor and analyze aquatic systems, especially water quality and levels of biological diversity.	Individuals, through personal, community, and governmental action, determine methods for achieving sustainable water management at all levels of the community. They conduct long- and short-term cost/benefit analyses to ensure adequate supplies of clean water to meet human needs and to preserve natural systems.	Using their knowledge, skills, and values, informed citizens make responsible decisions about the development, efficient use, regulation, conservation, and protection of water resources. They take responsible action based on the analysis of benefits, costs, tradeoffs, and long-term effects on the natural and built environments.

Conceptual Matrix Framework Correlations

CONTENT PROCESS	**NATURAL ENVIRONMENT** Natural Systems and Interactions	**BUILT ENVIRONMENT** Human Alterations to Natural Systems	**PERSONAL ENVIRONMENT** Citizens' Roles, Responsibilities, Choices, and Actions
FOSTERING AWARENESS AND APPRECIATION OF THE ENVIRONMENT	**Science:** energy, systems and interactions, stability. **History/Social Science:** basic study skills. **English/Language Arts:** oral language skills, composition skills, the art of questioning. **Mathematics:** mathematical ideas and mathematical thinking. **Visual and Performing Arts:** aesthetic valuing. **Health:** personal health and environmental health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8706.**	**Science:** energy, scale and structure, patterns of change. **History/Social Science:** basic study skills; ethical, cultural, historical , sociopolitical, economic, and geographic literacy. **English/Language Arts:** oral language skills, composition skills, the art of questioning. **Mathematics:** mathematical ideas and mathematical thinking. **Visual and Performing Arts:** aesthetic valuing . **Health:** personal health; consumer and community health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8701 and 8704.**	**Science:** systems and interactions. **History/Social Science:** basic study skills; ethical and geographical literacy; civic values, rights and responsibilities, and constitutional heritage. **English/Language Arts:** oral language skills, composition skills, the conventions of language, the art of questioning. **Mathematics:** mathematical ideas and mathematical thinking. **Visual and Performing Arts:** aesthetic valuing. **Physical Education:** self-image and personal development. **Health:** personal health and environmental health. **California Education Codes: Chapter 4 Environmental Education, Article 2, Section 8704 and 8705.**
UNDERSTANDING BASIC ENVIRONMENTAL CONCEPTS	**Science:** energy, scale and structure, stability, systems and interactions. **History/Social Science:** basic study skills, critical thinking skills,and geographical literacy. **English/Language Arts:** oral language skills, composition skills, the conventions of language, the art of questioning. **Mathematics:** mathematical ideas, mathematical thinking, mathematical tools and techniques. **Visual and Performing Arts:** artistic perception. **Health:** environmental health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8704 and 8706.**	**Science:** energy, scale and structure, patterns of change. **History/Social Science:** basic study skills; critical thinking skills; cultural, geographical, historical, sociopolitical, and economic literacy. **English/Language Arts:** oral language skills, composition skills, the conventions of language, the art of questioning. **Mathematics:** communication, mathematical ideas, mathematical tools and techniques, mathematical thinking. **Health:** consumer and community health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8701 , 8704, and 8707.**	**Science:** systems and interactions. **History/Social Science:** basic study skills; critical thinking skills; ethical, geographical, and economic literacy; civic values, rights and responsibilities. **English/Language Arts:** oral language skills, composition skills, the conventions of language, the art of questioning. **Mathematics:** communication, mathematical ideas, mathematical tools and techniques, mathematical thinking. **Visual and Performing Arts:** aesthetic valuing. **Physical Education:** self-image and personal development. **Health:** personal health and environmental health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8704, 8705 and 8707.**
TAKING RESPONSIBLE ACTIONS TOWARD THE ENVIRONMENT	**Science:** energy, systems and interactions, stability, patterns of change. **History/Social Science:** geographical literacy, critical thinking skills, participation skills. **English/Language Arts:** oral language skills, composition skills, the conventions of language, the art of questioning. **Mathematics:** communication, mathematical ideas, mathematical tools and techniques, mathematical thinking. **Visual and Performing Arts:** creative expression. **Physical Education:** social development. **Health:** environmental health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8701, 8705, 8706, 8707.**	**Science:** energy, scale and structure, patterns of change. **History/Social Science:** critical thinking skills; ethical, historical, geographical, economic, sociopolitical, and cultural literacy; and participation skills. **English/Languge Arts:** oral language skills, composition skills, the conventions of language, the art of questioning. **Mathematics:** communication, mathematical ideas, mathematical tools and techniques, mathematical thinking. **Visual and Performing Arts:** creative expression. **Physical Education:** social development. **Health:** consumer and community health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8701, 8704, 8705, 8707.**	**Science:** energy, systems and interactions, scale and structure. **History/Social Science:** critical thinking skills; ethical, geographic, economic, sociopolitical literacy; civic values, rights and responsibilities, and participation skills. **English/Language Arts:** oral language skills, composition skills, the conventions of language, the art of questioning. **Mathematics:** communication, mathematical ideas, mathematical tools and techniques, mathematical thinking. **Visual and Performing Arts:** creative expression. **Physical Education:** social development. **Health:** personal health and environmental health. **California Education Code: Chapter 4 Environmental Education, Article 2, Section 8701 , 8704, 8705, and 8707**

Water Resources Evaluation Tool

The following environmental education evaluation instrument was used by the project's reviewers to evaluate the water resources curricula. This instrument reflects the recommendations and perspectives of the following documents:

"1992 Science Instructional Materials Evaluation Form," California Department of Education, 1992.

Andrews, Bill, "Background Paper I: Environmental Education Strategy of the California Department of Education," California Department of Education.

Energy Education Evaluation Form - the evaluation tool used for the Water Resources and Energy Resources compendia published in 1992.

Gardella, Ron, Environmental Education Curriculum Inventory (Forms A and B), Northern Kentucky University, Highland Heights, KY, 1992.

Health Framework for California Public Schools (pp.184-195), California Department of Education, 1994.

History-Social Science Framework for California Public Schools (pp. 114-120), California Department of Education, 1988.

Niedermeyer, Fred, "A Checklist for Reviewing Environmental Education Programs" (pp. 46-50), *Journal of Environmental Education*, Vol. 23, 1992.

Olson, Betsy, "Environmental Education Instructional Materials Evaluation Form," California Department of Education (draft).

Science Framework for California Public Schools (Chapter 8, pp. 198-213), California Department of Education, 1990.

Science Resource Center, "Rating System for ME-2," Los Angeles Unified School District.

"The Superintendent's Point of View on Environmental Education," California Department of Education, 1990.

UNESCO, "The Belgrade Charter," UNESCO-UNEP Environmental Education Newsletter, Volume I, Number 1, January 1976.

UNESCO, "The Tbilisi Declaration," October 1977.

I. Criteria For Instructional Materials

A. General Content

1. Are ideas expressed through unifying themes and big ideas, not facts?
2. Is content interdisciplinary?
3. Are students challenged to utilize age-appropriate higher level thinking processes?
4. Are ideas presented logically and connected through the curriculum?
5. Is depth of understanding emphasized (rather than encyclopedic breadth)?
6. Are historical, ethical, cultural, geographic, economic, and sociopolitical relationships addressed?
7. Are the learning process and the acquisition of knowledge shown as connected to the students' lives and society?

B. Presentation

1. Are instructional materials clearly and engagingly written with the main concepts well articulated?
2. Are the roles of environmental ethics, citizenship, and stewardship explored?

3. Do lessons promote respect and caring for the environment, yet are nondogmatic and open to inquiry and differences of opinion?

4. Are personal and societal values and conflicting points of view explored in context?

5. Are instructional materials easy for students to use and understand?

6. Is learning made accessible to limited English proficiency (LEP) students?

7. Are writings and concepts developmentally appropriate for the designated grade, yet sensitive to individual differences in educational experience and learning mode?

8. Is environmental responsibility modeled in design, underlying philosophy, and suggested activities by the lessons and materials (e.g., using recycled materials, creating minimal amounts of wastes, and properly disposing of the wastes)?

9. Are there clear linkages between communities of all levels ("thinking globally, acting locally")?

10. Are vocabulary words defined in context and not dominating of learning goals?

11. Is the layout of instructional materials interesting and appealing?

C. Pedagogy

1. Does almost half of the curriculum have students engaged in active learning?

2. Is learning based on the students constructing knowledge through research, discussion, and application to gain conceptual understanding?

3. Are evaluation devices included, appropriate, and aligned with the objectives of outcomes presented? (Highest points for authentic, performance-based assessment devices.)

4. Are instructional materials sensitive to social, economic, and cultural diversity?

5. Do lessons encourage students to develop awareness, knowledge, and strategies for responsible action?

6. Are group/cooperative learning strategies used?

7. Is intergenerational responsibility, linking today's actions with future consequences, implicit in instructional methods?

D. Teacher Usability

1. Are instructions for the teacher clear and concise?

2. Are lesson objectives/outcomes clear and appropriate?

3. Are materials easily integrated into an established curriculum?

4. Is background information for the teacher adequate and accurate?

5. Can the materials be adapted to varied learning environments (large/small classes, of mixed levels, from rural/urban settings)?

6. Are consumable instructional materials of good quality, easily duplicated for student use, and in sufficient quantity to support the objectives?

7. Are equipment/materials listed and reasonably accessible?

8. Do the materials suggest a variety of instructional strategies,

expanded learning environments, and resources in the curriculum's design?

9. Is the time required to complete each lesson indicated?

10. Do the materials clearly list the subject discipline(s) integrated into each lesson?

E. Water Resources Content Questions

Do the Materials Provide Opportunities for Students to:

1. Appreciate that water is necessary for life?

2. Appreciate the roles topography, climate, and the hydrologic cycle play in an ecosystem?

3. Identify the physical and chemical properties of water?

4. Understand all steps in the hydrologic cycle?

5. Appreciate the relationship between personal behavior and the availability of clean water in natural and built environments?

6. Identify sources of water supplies used locally, including groundwater, surface water, and reclaimed water?

7. Understand the role of water supply systems for delivering water to meet human needs?

8. Acquire personal problem-solving and decision-making skills related to water resource issues?

9. Identify the causes and effects of water pollution and shortages?
10. Practice conserving water resources with sustainable water use as the goal?

II. Narrative/Miscellaneous

A. Briefly comments on the strengths of the curriculum.

B. Briefly comments on the weakeness of the curriculum.

C. Other comments.

D. If it focuses on a specific geopolitical area not including California, can is easily be adapted to the needs of California teachers?

E. Are the materials available in more than one language? If so, what part of the curriculum and which languages?

F. Do the materials contain a listing of resources, such as an appendix or teacher resource guide?

G. In the table below, check the appropriate box next to each discipline to estimate the amount of emphasis each is given in the curriculum.

Supplemental Materials

Although each of the following materials did not qualify as a formal curriculum, each may serve as a useful supplemental resource.

4-H Soil and Water Conservation Manuals (5 - 12)
Leader's guide (21 pages [p].) and four student manuals (level A, 42 p., level B, 54 p., level C, 61 p., level D, 68 p.) guide 4-H club members through an independent learning program based on soil and water conservation. Agricultural Communications Service, Media Distribution Center, Purdue University, 301 South 2nd Street, Lafayette, IN 47901-1232 (317) 494-6794.

Acid Rain Curriculum (4 - 8)
Folder of twelve classroom activities explore the origin of acid rain, the pH scale, and political problem-solving (76 p.). Acid Rain Foundation, 1410 Varsity Drive, Raleigh, NC 27606 (919) 828-9443.

American Wetlands Month materials
Wetland fact sheets and associated materials are available to help support community events dedicated to wetland restoration and protection. Terrene Institute, 4-B Herbert Street, Alexandria, VA 22305 (703) 548-5473.

Animal Tracks (4 - 6)
Activity guide (161 p.) and student book (80 p.) introduce environmental topics from the perspectives of animals. Two of eleven activities focus on water conservation and water quality. National Wildlife Federation, 1400 Sixteenth Street, N.W., Washington, D.C. 20036-2266 (800) 822-9919.

Backyard Acid Rain Kit Program (3 - 6)
Folder of fact sheets, brochures, pH indicator strips, and program guide (121 p.) offer students the opportunity to monitor acidity levels in precipitation and participate in classroom investigations. The Green Brick Road, Distributors, 8 Dumas Court, Don Mills, Ontario, M3A 2N2, Canada (416) 465-1597.

Be Water Wise (K - 5)
Part of the Newspaper in Education program, "Be Water Wise" offers a folder of water conservation information, including a Mr. Leaky poster, student booklet, "Water Conservation and You!" (8 p.), and activity guide with blackline masters focusing on the use of the *Sacramento Bee* newspaper to explore water conservation (13 p.). The Sacramento Bee, P.O. Box 15779, Sacramento, CA 95852 (916) 321-1786.

Blue Thumb Project
"Blue Thumb Project" materials are designed to promote water-responsible action in conjunction with the annually-celebrated Drinking Water Week. Strategies to "exercise a blue thumb" in the conservation of water, together with posters and suggestions for organizing community campaigns, dealing with the media, and involving children, are offered. American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235 (303) 794-7711.

Coastal Issues: A Wave of Concern (7 - 12)
"Coastal Issues" is a science and social science curriculum based on a study of human activities and the resultant pressure on natural resources in New Hampshire's coastal areas (107 p.). University of New Hampshire Sea Grant Extension Program, Kingman Farm, Durham, NH 03824-3512 (603) 749-1565.

Educating Young People about Water (K - 12)
Three booklets entitled "A Guide to Program Planning and Evaluation," "A Guide to Unique Program Strategies," and "A Guide to Goals and Resources," and the video "Planning for Fun and Success" offer a systematic approach to integrating water education into the curriculum. University of Wisconsin - Extension, Environmental Resources Center, 1450 Linden Drive, Room 216 Ag Hall, Madison, WI 53706 (c/o ERIC (800) 276-0462.

EnviroScape II
Watershed model demonstrates water pollution, and specifically, how land activities affect water quality. Urban, industrial, agricultural, highway, forest, streambank, and lake shore features are depicted; all necessary props are included. Terrene Institute, 4-B Herbert Street, Alexandria, VA 22305 (703) 548-5473.

Supplemental Materials

Experiencing Water Resources, a Guide to Your River Basin (3 - 5)
Teacher's guide (75 p.) and student workbook (27 p.) present four units focusing on watershed, water and agriculture, salmonid fisheries, and water quality. Activities encourage exploration of a specific river basin in the students' community. Cooperative Extension, Cooper Publications Building, Washington State University, Pullman, WA 99164-5912 (509) 335-2857.

Freshet Finds a Way - Integrated Teaching Lessons and
Freshet Finds a Way - A Trip Through the Hydrologic Cycle (K - 6)
Teacher's guide (19 p.) and accompanying book (13 p.) trace the journey of a water drop from Northern to Southern California, emphasizing geography, the water cycle, and water in art. Helix Water District, 8111 University Avenue, P.O. Box 518, La Mesa, CA 91944-0518 (619) 466-0585.

FUTURES - Water Engineering and
Interactions: Real Math - Real Careers (7 - 12)
Designed to motivate students to study science and mathematics, "FUTURES" demonstrates the importance of both fields in career and "real world" applications. Each video is accompanied by a Teacher's Guide (47 p. and 14 p. draft, respectively) which provides background information and student activities. "FUTURES" features Jaime Escalante as narrator; "Interactions" features twelve episodes of professionals, including those in water resources, applying math in their daily work. The Foundation for Advancements in Science and Education (FASE) Productions, 4801 Wilshire Blvd., Suite 215, Los Angeles, CA 90010 (213) 965-8794.

Gateway to the Pacific: The Columbia River (5 - 7)
Developed through the Pacific Circle Consortium's Ocean Project, Gateway to the Pacific focuses on the interdependence of Pacific nations through ocean trade. A study of the Columbia River introduces students to its history, the use of the harbor, and the harbor environment through geography, history, and language arts (147 p.). Oregon State University (OSU), Hatfield Marine Science Center, 2030 Marine Science Drive, Newport, OR 97365 (541) 867-0257.

Give Water a Hand Site Action Guide and **Leader Guidebook**
Youth Action Guide (72 p.) and accompanying **Leader's Handbook** (40 p.) provide information on how to select and organize an environmental service project. Strategies to promote the "Give Water a Hand" program, pair youth with local water experts, locate resources, and research and implement local water-related projects are provided. Cooperative Extension, University of Wisconsin-Extension, Environmental Resource Center, Agricultural Hall, Room 216, 1450 Linden Drive, Madison, WI 53706-1562 (800) 928-3720.

Groundwater Festival Outreach Packet (K - 6)
Activities integrating science and math, language arts and social science, fine arts and physical education, and a rich selection of games are designed to increase student awareness of groundwater resources in Nebraska (70 p.). Nebraska Groundwater Foundation, P.O. Box 22558, Lincoln, NE 68542-2558 (800) 858-4844.

Groundwater Adventure Unit (7 - 9)
Video, teacher's guide (40 p.), and student workbook (29 p.) focus on the importance of groundwater, the ways it becomes polluted, and strategies to protect it. Activities include discussions and demonstrations of percolation, the water cycle, groundwater quality and layering. Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994 (800) 666-0206.

Groundwater Model
Constructed of plexiglass and filled with sand, gravel, and clay, the model demonstrates the movement of groundwater. Water Education Foundation, 717 K Street, Suite 517, Sacramento, CA 95814 (916) 444-6240.

It's Found Underground: Groundwater, Our Buried Treasure (4 - 9)
Thirty-one minute video is accompanied by a study guide (20 p.) that provides background information and classroom activities on groundwater, groundwater flow pollution, and the movement of waste and water in landfills. Ecology Center of Ann Arbor, 117 North Division Street, Ann Arbor, MI 48104 (313) 995-5888.

Liquid Explorations (1 - 3)
Five investigations help students acquire scientific skills as they focus on the properties of liquids (71 p.). Great Explorations in Math and Science, Lawrence Hall of Science, University of California, Berkeley, Berkeley, CA 94720-5200 (510) 642-7282.

Liquid Treasure Water History Trunk: Learning from the Past (4 - 12)
Book provides instruction for the creation of a Liquid Treasure Water History Trunk to be filled with artifacts and related materials the students collect. Through the activities, students explore the lifestyles and water use issues of ancestors and other cultures (64 p.). Project WET and The Watercourse, 201 Culbertson Hall, Montana State University, Bozeman, MT 59818 (406) 994-5392.

Local Watershed Problem Studies (K - 6)
Curriculum guide examines the interface between land use and non-point source water pollution. Activities are divided into four sections: natural systems, investigating non-point source pollution, attitudes about ecology, and water usage (148 p.). University of Wisconsin, Water Resources Center, 1975 Willow Drive, Madison, WI 53706 (608) 262-3577.

Local Watershed Problem Studies (7 - 12)
Curriculum guide examines the interface between land use and non-point source water pollution. Activities range from simulation studies of pollution control to actual monitoring of pollutants (328 p.). University of Wisconsin, Water Resources Center, 1975 Willow Drive, Madison, WI 53706 (608) 262-3577.

NatureScope: Pollution Solutions (K - 8)
Resource book of multidisciplinary activities and background information on trash and toxics, air pollution, water pollution, choices and challenges (84 p.). National Wildllife Federation, 1400 Sixteenth Street, N.W., Washington, D.C. 20036-2266 (800) 822-9919.

NatureScope: Wading into Wetlands (K - 8)
Resource Book of multidisciplinary activities and background information on salt water and freshwater wetlands (65 p.). National Wildlife Federation, 1400 Sixteenth Street, N.W., Washington, D.C. 20036-2266 (800) 822-9919.

Paddle to the Sea: Supplemental Curriculum Activities (3 - 6)
The 1941 classic *Paddle-to-the-Sea* book by Holling Clancy Holling is accompanied by a diverse collection of supplemental curriculum activities produced by the Ohio Sea Grant Education Program (152 p.). Book tells the story of a small canoe, carved by an Indian boy, which makes a journey from Lake Superior to the Atlantic Ocean. Ohio Sea Grant, Ohio State University, 1314 Kinnear Road. Columbus, OH 43212-1194 (614) 292-8949.

Project WET Water Celebration, a Handbook
Handbook offers specific suggestions for organizing a water celebration to educate a community about the importance of water. Information includes potential locations, schedules, target audiences, themes, potential supporters and partners, and techniques for working with educators and the media (32 p.). The Watercourse, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717 (406) 994-5392.

Ricki and the Forms of Water (K), **The Water Cycle** (1)
The Water Cycle - Ricki the Rambunctious Raindrop Activity Book (2)
Traveling with Ricki the Rambunctious Raindrop (3)
Collection of coloring books illustrate the water cycle, uses of water, and course of water distribution to Orange County using the "Ricki the Rambunctious Raindrop" character. Municipal Water District of Orange County, P.O. Box 20895, Fountain Valley, CA 92728-0895.

Saving Water Conservation Unit (7 - 9)
Video, teacher's resource guide (40 p.), and student resource guide (29 p.) focus on human uses of water, its finite supply, and strategies to conserve it. Hazardous waste and its effect on water resources are emphasized throughout the program. Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994 (800) 666-0206.

474

475

Supplemental Materials

Surface Water Unit (5 - 8)
Video, teacher's guide (40 p.), and student resource guide (29 p.) explain what surface water is, how it becomes polluted through natural and human activity, and how water pollution can be controlled. Distinction is made of different types of surface water, natural surface water pollution (e.g. thermal pollution), human pollutants, and the "natural clean water cycle" occurring through dissipation, biodegradation, and filtration. Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994 (800) 666-0206.

Teacher's Guide for Hands-On Water Activities (1 - 6)
Four science activities explore the availability of fresh water, surface tension, pressure, and rain measurement using homemade rain gauges (17 p.). California Department of Water Resources, Office of Water Education, P.O. Box 942836, Sacramento, CA 94236-0001 (916) 653-1097.

The California Water Map (English or Spanish), **The Delta Map, Colorado River Water Map**, **Ground Water Map**, and **California's Water System Poster** Posters are available in large, full color format for use in water education programs. Water Education Foundation, 717 K Street, Suite 517, Sacramento, CA 95814 (916) 444-6240.

The California Water Works, Why It Does (4 - 8), (bilingual)
Booklet provides an overview of the water cycle, natural and built water systems in California, and tips for water conservation (16 p.). California Department of Water Resources, Office of Water Education, P.O. Box 942836, Sacramento, CA 94236-0001 (916) 653-1097.

The Columbia River: Its Future (9 - 12)
This is a multidisciplinary study of the Columbia River: political and economic aspects, historical perspectives, and biological resources. Activities are grouped according to history, energy, navigation, fisheries, agriculture, and recreation (76 p.). Publications Orders, Agricultural Communications, Oregon State University, Administrative Services A422, Corvallis, OR 97331-2119 (503) 737-2513.

The Columbia River: Its Future and You (5 - 8)
The basics of the Columbia River system are covered in this curriculum guide. Activities integrate general information with energy, fisheries, agriculture, history, recreation, and navigation (85 p.). Publications Orders, Agricultural Communications, Oregon State University, Administrative Services A422, Corvallis, OR 97331-2119 (503) 737-2513.

The Water Story (K - 6)
Magazine-format booklet for students features stories, gameboard, poster, and activities exploring water usage with a multicultural perspective (14 p.). Falcon Magazine and Project WET, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717 (406) 994-5392.

Wastewater Treatment Unit (7 - 9)
Video, teacher's resource guide (40 p.), and student resource guide (29 p.) focus on water quality, wastewater treatment, and the handling of wastewater, effluent, and sludge. Water Environment Federation, 601 Wythe Street, Alexandria, VA 22314-1994 (800) 666-0206.

Water and Our Waterways, The Essence of Life (K - 8)
Open-ended and self-directed study units encourage students to individually explore water creatively and scientifically (71 p.). Zephyr Press, P.O. Box 66006, Tucson, AZ 85728-6006 (520) 322-5090.

Water Colors (K- 1)
Coloring/activity book (16 p.) features the *H2Cool* water drop as it explores the benefits of water. The book is accompanied by a seed packet. Andonian, Bauer, Holland Design Group in conjunction with Santa Clara Valley Water District, 307 Orchard City Drive, Suite 302, Campbell, CA 95008 (408) 379-3744.

Water Conservation and Nonpoint Source Pollution (K - 6)
This guide (94 p.) is actually a compilation of activities from four publications: the Utah Nonpoint Source Pollution Education Activities, Groundwater Flow Demonstration Model Activities, The Comprehensive Water Education

Supplemental Materials

Book, and Ridges to Rivers. These latter two have been reviewed in the main body of the compendium. International Office for Water Education, Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200 (801) 797-3232.

Water Education Workbook (K - 6)
Teacher's Guide (34 p.), Water Education Workbook (34 p.), and Water for People and Farms poster provide background information and activities based primarily on discovering water supplies and distribution within Kern County, and water quality and conservation. Some of the activities are from the AIMS Foundation's Water Precious Water. Kern County Water Agency, P.O. Box 58, Bakersfield, CA 93302-0058.

Water Journeys (4 - 5)
Teacher's guide (3 p.), student journal (14 p.), and student booklet (14 p.) focus on the journey of water from reservoir to water treatment plant to home faucet. Andonian, Bauer, Holland Design Group in conjunction with Santa Clara Valley Water District, 307 Orchard City Drive, Suite 302, Campbell, CA 95008 (408) 379-3744.

Water Junction and The Kids of Hubcap Flats (1 - 3)
Teacher's Guide (4 p.), student science journal (22 p.), student booklet (22 p.) and cassette focus on the water cycle, water properties, and conservation. Andonian, Bauer, Holland Design Group in conjunction with Santa Clara Valley Water District, 307 Orchard City Drive, Suite 302, Campbell, CA 95008 (408) 379-3744.

Water Matters (3 - 8)
A series of water resources posters depict wetlands, water use, and wastewater treatment. Background information and activities provided on the back of each poster are complemented by the teacher's guide, which offers further background information, additional activities, and suggestions on how to merge water resources education into existing curricula (31 p.). National Science Teachers Association, 1840 Wilson Boulevard, Arlington, VA 22201 (703) 243-7100.

Water Play (K - 3)
Produced as part of Project WATER (Water Awareness through Education and Research), the teacher's guide (24 p.) and student booklet (15 p.) offer multidisciplinary classroom activities on water awareness and water conservation. Public Information, East Bay Municipal Utility District, P.O. Box 24055, Oakland, CA 94623 (510) 287-0138.

Water-Related Teaching Activities Book (K - 12)
Older (1977) collection of activities, primarily based in science and social science, with some emphasis upon mathematics and art. Water cycle, water properties, water use, pollution and technology are examined (149 p.). ERIC/CSMEE, 1929 Kenny Road, Columbus, OH 43210 (800) 276-0462.

Water Riches Curriculum (3 - 5)
Teacher's guide (34 p.), five-issue packet of the Water Riches newspaper, and corresponding set of five videos are designed to teach students about water conservation through articles and activities presented in a newsroom format. Bulletin Distribution, University of Nebraska - Lincoln, P.O. Box 830918, Lincoln, NE 68583-09180, (402) 472-9713.

Water - Where It Comes From and Where It Goes and
More About Water - Where It Comes From and Where It Goes
Designed for the student and adult reader, respectively, these two booklets provide a detailed account of water supplies, treatment, and distribution in the East Bay region (7 p. and 10 p., respectively). Public Information Office, East Bay Municipal Utility District, P.O. Box 24055, Oakland, CA 94623-1055 (510) 287-0138.

Water Wise: Lessons in Water Resources (5 - 6)
Background information and activities focus on the properties of water, the water cycle, surface water and groundwater, water contamination, water treatment and purification, and conservation (85 p.) Cornell Cooperative Extension, Media Services Resource Center, 7 Business and Technology Park, Ithaca, NY 14850 (607) 255-2080.

Supplemental Materials

Water Wizards (3 - 4)
Five lessons with reproducible masters are featured in a teacher's guide (30p.) that focuses on the water cycle, sources of drinking water in Massachusetts, water use, and conservation. Massachusetts Water Resources Authority, School Programs, Charlestown Navy Yard, 100 First Avenue, Boston, MA 02129 (617) 242-6000 x4175.

Watershed Management Game (Adult)
Game challenges two to four adult players to reach the final ocean checkpoint while successfully protecting the watershed's water quality. Terrene Institute,
4-B Herbert Street, Alexandria, VA 22305 (703) 548-5473.

Why Wetlands? Education Kit (7 - 9)
Binder offers twenty-two activities, posters, factsheets, and student handouts that focus on wetlands, water, wildlife, and people from a Canadian perspective (165 p.). The Green Brick Road, Distributors, 8 Dumas Court, Don Mills, Ontario, M3A 2N2, Canada (416) 465 - 1597.

Wilderness and Land Ethic Curriculum (K - 8)
The Wilderness Box offers a collection of instructional aids used in conjunction with the "Wilderness and Land Ethic Curriculum" (395 p.). Based on a study of the National Wilderness Preservation System, the curriculum offers sequential activities based on three grade-groups: K-2, 3-5, and 6-8. The concept of wilderness is explored from a myriad of benefits, ranging from scientific value and watershed protection to spiritual value and historical/ cultural richness. Wilderness Education Project, Yosemite National Park - Wilderness Center, P.O. Box 577, Yosemite, CA 95389 (209) 372-0735.

Youth Education Package (K - 3)
Classroom set of materials includes "Water Magic" Teacher's Guide (48 p.) with 23 water-based activities; "Water Hog Haven" video; Use Water Wisely poster; 30 copies of the "Splash Activity Book" (16 p.), a coloring book with games; and 30 Conserve Water stickers. American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235 (303) 794-7711.

Youth Education Package (4 - 7)
Classroom set of materials includes the "Teacher's Guide to the Story of Drinking Water" (64 p.) with background information, classroom activities, and reproducible worksheets; 3-2-1- Contact "Down the Drain" video; educational poster set; 30 copies of "The Story of Drinking Water" (15 p.) with information on the water cycle, water treatment, and distribution - available in English, Spanish, and French;, and 30 copies of "Water-Saving Tips for Kids, by Kids." American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235 (303) 794-7711.

430

431

Water Quality Monitoring Resources

The following materials contain activities that emphasize sample collection procedures, analytical equipment and techniques, data interpretation, and opportunities for sharing findings with other individuals and agencies.

A Guide to Streamwalking (K - 12)
North Carolina-focused book provides an overview of stream and river characteristics, aquatic organisms, watershed mapping, and sampling techniques. Identification keys, data sheets, and tables are provided (64 [p.]). North Carolina Division of Water Resources, P.O. Box 27687, Raleigh, NC 27611 (919) 733-4064.

A Study of Water Quality (5 - 12)
Small booklet (46 [p.]) discusses the water cycle, the physical and chemical processes occurring in natural water supplies, water treatment, and pollutants. LaMotte Company, 802 Washington Ave., P.O. Box 329, Chestertown, MD 21620 (800) 344-3100.

Acid Rain Study Kit (5 - 12)
Acid Rain Study Guide (14 [p.]), Acid Rain Study Activities (9 [p.]), rain gauge, and Wide Range pH Test Kit are packaged together for classroom investigations using rainwater, puddles, or tapwater. LaMotte Company, 802 Washington Ave., P.O. Box 329, Chestertown, MD 21620 (800) 344-3100.

Adopting a Stream, a Northwest Handbook (7 - 12)
Pacific Northwest-focused book describes the stream environment, including fish, aquatic insects, and stream ecology, and offers extensive background information on Adopt-A-Stream Projects (135 p.). Adopt A Stream Foundation, NW Stream Center, 600 128th Street, S.E., Everett, WA 98208 (206) 316-8592.

Adopting A Wetland, a Northwest Handbook (7 - 12)
Pacific Northwest-focused book describes the wetland environment, including marshes, swamps, bogs, wet meadows, and tidal flats, and offers suggestions for wetland restoration and protection projects (38 [p.]). Adopt A Stream Foundation, NW Stream Center, 600 128th Street, S.E., Everett, WA 98208 (206) 316-8592.

Dipping into Creeks (4 - 6)
Classroom packet of material is designed to help educators utilize local creeks for science instruction. The packet contains Creek Life and Creek Ecology booklet (57 [p.]), How To Adopt-A-Creek pamphlet (8 [p.]), A Collection of Creek Activities pamphlet (14 [p.]), Sponges (mini activities) booklet (32 [p.]), and glossary. Map of Sacramento County Creeks is also included. Sacramento Chapter, Urban Creeks Council, 5225 Atlanta Way, Sacramento, CA 95841 (916) 332-3775.

Field Manual for Water Quality Monitoring (7 - 12)
Data collection, in the form of water quality testing, and environmental problem-solving, in the form of action projects, are the focus of this book. Nine water quality parameters, heavy metals, and benthic macroinvertebrates are discussed and interpreted. Additional topics include land use practices, Global Rivers Environmental Education Network (GREEN) case studies, and computer networking (272 [p.]). William Stapp, 2050 Delaware Avenue, Ann Arbor, MI 48103.

Field Manual to Global, Low Cost Water Quality Monitoring (7 - 12)
Designed to complement the Field Manual for Water Quality Monitoring and promote the Global Rivers Environmental Education Network, this field manual provides information on monitoring options that are inexpensive and require little technology. Equipment-making instructions, support materials, and student activities are included (335 [p.]). Global Rivers Environmental Education Network (GREEN Project), 721 East Huron Street, Ann Arbor, MI 48104 (313) 761-8142.

Global Rivers Environmental Education Network (GREEN Project), (K - 12)
Using reference material described in this section of the compendium, in addition to other curricula and resources, students monitor local watersheds based on nine factors and, from the data, determine a Water Quality Index for their site. Telecommunications with other participants in this international program is offered. Global Rivers Environmental Education Network, 721 East Huron Street, Suite 1, Ann Arbor, Michigan 48104 (313) 761-8142.

Water Quality Monitoring Resources

Global Thinking Project (5 - 12)
Through teacher attendance at an annual summer institute and use of the Global Thinking Resource Guide, middle through secondary level students investigate global environmental problems and report results through telecommunications. One unit in the guide is entitled Project Water Watch. Global Thinking Project, Department of Middle and Secondary Education and Instructional Technology, Georgia State University, Atlanta, GA 30303 (404) 651-2518.

Heavy Metals in Water (10 - 12)
This comprehensive guide is designed for use by educators interested in moving beyond standard water quality tests. Heavy metals monitoring and use of bioassays is covered thoroughly; case studies based on the Rouge River Education Project are featured (135 [p.]). Global Rivers Environmental Education Network (GREEN Project), 721 East Huron Street, Ann Arbor, MI 48104 (313) 761-8142.

Investigating Streams and Rivers (6 - 10)
This interdisciplinary curriculum guide is designed for use with *Field Manual for Water Quality Monitoring*. Activities are divided into three sections: Getting To Know the River, Monitoring Water Quality, and Problem-Solving. (57 [p.]). Global Rivers Environmental Education Network (GREEN Project), 721 East Huron Street, Ann Arbor, MI 48104 (313) 761-8142.

Lake Smart - Lake Maintenance Handbook (7 - 12)
This "user's guide" offers guidelines for lake and pond restoration projects. Several lake problems are covered, including algae and aquatic weeds, muddy water, sediments, waste disposal, and unwanted fish and waterfowl (216 [p.]). Terrene Institute, 4-B Herbert Street, Alexandria, VA 22305 (703) 548-5473.

Pondwater Tour Test Kit (4 - 8)
Teacher's binder (65 [p.]) offers background information, instructional strategies, and reproducible handouts to accompany pondwater testing supplies for four water quality parameters: dissolved oxygen, nitrate, pH, and ammonia. LaMotte Company, 802 Washington Ave., PO Box 329, Chestertown, MD 21620 (800) 344-3100.

Save Our Streams Kit (6 - 12)
Folder of materials features handouts, "Monitor's Guide to Aquatic Macroinvertebrates" (60 [p.]), Izaak Walton League of America literature on stream and wetland protection, Save Our Streams Stream Quality Survey material, and "A Citizen's Directory for Water Quality Abuses," which provides a basic understanding of water pollution indicators andlist of state environmental agencies to contact (16 [p.]). Isaak Walton League of America, 1707 Conservation Lane, Gaithersburg, MD 20878-2983 (301) 548-0150.

Tapwater Tour Test Kit (4 - 8)
Teacher's binder (46 [p.]) offers background information, instructional strategies, and reproducible handouts to accompany classroom tapwater testing supplies for pH, chlorine, hardness, copper, and iron. LaMotte Company, 802 Washington Ave., P.O. Box 329, Chestertown, MD 21620 (800) 344-3100.

The GLOBE Program (K - 12)
Through GLOBE, or Global Learning and Observations To Benefit the Environment, students investigate a local environment, analyze the data with assistance from scientists, transmit the data electronically to a processsing center, and receive back digital global images based on an analysis of their and other data. The Globe Program, 744 Jackson Place, N.W., Washington, D.C. 20503 (202) 395-7600.

The Ecoscope Wetlands Project (10 - 12)
Using Student Guides, a Teacher's Guide, case studies, fact sheets, and teleconferencing capabilities, students investigate and evaluate a local wetland. A conservation strategy is developed and implemented; information is shared with the community and with students in other regions through computer teleconferencing. The Common Heritage Programme, R.R. #2, Almonte, Ontario, Canada K0A 1A0 (613) 256-1487.

The Monitor's Handbook (5 - 12)
Booklet (71 [p.]) explains the essence of water quality monitoring and provides specific analytical procedures for measuring water quality factors including pH, dissolved oxygen, biochemical oxygen demand, nitrate,

Water Quality Monitoring Resources

phosphate, coliform bacteria, and total dissolved solids. Conversion factors, a glossary, and suggestions for organizing a volunteer water quality monitoring program are also provided. LaMotte Company, 802 Washington Ave., P.O. Box 329, Chestertown, MD 21620 (800) 344-3100.

Water Quality (10 - 12)
Designed in collaboration with the Rivers Project (evaluated in the compendium), the Water Quality binder (147 [p.]) offers seven lessons that focus on environmental chemistry and water quality monitoring. Students collect data in the field to answer questions based on their own observations. Reproducible worksheets and an inventory of materials are provided. Adopt A Watershed Program, P.O. Box 356, Hayfork, CA 96041 (916) 628-5334.

Water Quality (10 - 12)
The Water Quality classroom module focuses on water quality as it relates to a public water supply system. The box contains a 13 minute video, teacher's guide (25 [p.]), classroom set of student pretests and post-tests, California Water Resources Map, classroom set of student booklets (27 [p.]), water sample mixtures, and six slides with microorganisms. Turbidity, pH, hardness, and microorganisms are examined in the prepared samples. Classroom activities, a glossary, and enrichment activities are offered. Metropolitan Water District of Southern California, P.O. Box 54153, Los Angeles, CA 90054-0153 (213) 217-6398.

Water Quality Sampling Equipment (4 - 12)
Designed to familiarize teachers and students with water quality sampling equipment, this booklet describes the use and limitations of a water sampler, secchi disk, water test kit, invertebrate and plankton sampling equipment, artificial substrate samplers, fish sampling equipment, field sampling supplies, laboratory supplies, and field attire (16 [p.]). Tennessee Valley Authority, Water Quality Dept. Library, 1101 Market Street, 2C Haney Building, Chattanooga, TN 37327 (423) 751-7338.

Water Quality Testing Program (7 - 12)
The Water Quality Testing Program consists of a Teacher's Manual (100 [p.]) and Water Quality Testing Kit for use in a freshwater, estuarine, or marine environment. The manual offers background information, suggested activities, field testing procedures, data collection procedures, and reproducible handouts. The water tests include pH, dissolved oxygen, biochemical oxygen demand, nitrates, turbidity, total dissolved solids, hardness, and microorganisms. Additional support by the San Diego County Water Authority includes six digitized wall maps of San Diego's watersheds and a computer program for interpretation of the students' field test data. San Diego Water Authority, 3211 Fifth Avenue, San Diego, CA 92103 (619) 682-4131 (619) 682-4131.

Water Studies for Younger Folk (5 - 8)
Based on the *Field Manual for Water Quality Monitoring*, this manual provides an overview of water quality monitoring and "how to" instructions for classroom activities and field activities, including performing tests on dissolved oxygen, fecal coliform, biochemical oxygen demand, temperature, total phosphorous, nitrate nitrogen, pH, total solids, and turbidity (31 [p.]). Global Rivers Environmental Education Network (GREEN Project), 721 East Huron Street, Ann Arbor, MI 48104 (313) 761-8142.

Water, Water, Everywhere (7 - 12)
Materials for Water, Water, Everywhere include the Teacher's Guide (65 [p.]), Student Reading Unit (36 [p.]), and Water Quality Factors Reference Unit (44 [p.]). Using water quality and pollution as the topic, the program integrates reading, discussion, and nine environmental science activities using Hach test kits. Hach Equipment Company, P.O. Box 389, Loveland, CO 80539-0389 (800) 227-4224.

Software

The following list of software focuses on water-related topics.

Adventures of a Water Drop (Mac), (4 - 8)
Chariot Software, 3593 India Street, San Diego, CA 92103 (800) 242-7468.

California Hydroexplorer (IBM and Mac), (4 - 6 and 7 - 12)
Water Education Foundation, 717 K Street, Suite 517, Sacramento, CA 95814
(916) 444-6240.

Cleanwater Detectives (Apples), (3-6)
MECC, 6160 Summit Drive North, Minneapolis, MN 55430-4003
(800) 685-MECC.

Colorado Hydroexplorer (IBM and Mac), (4 - 6 and 7 - 12)
Water Education Foundation, 717 K Street, Suite 517, Sacramento, CA 95814
(916) 444-6240.

Eutroph - Water Quality Determination and Evaluation
(Apple IIe), (6 - 12)
Educational Images Ltd., P.O. Box 3456, Westside Station, Elmira, New York,
14905 (800) 527-4264.

Every Drop Counts (IBM), (7 - 9)
Modesto Irrigation District, 1231 Eleventh Street, P.O. Box 4060, Modesto,
CA 95352 (209) 526-7390.

Exploring Freshwater Communities (CD-ROM), (7 - 12)
Educational Images Ltd., P.O Box 3456, Westside Station, Elmira, New York,
14905 (800) 527-4264.

FOSS (Full Option Science System) Water Module
(videodisc in MS-DOS, Mac and Windows), (4 - 6, bilingual)
Encyclopaedia Britannica Educational Corporation, 310 South Michigan
Avenue, Chicago, IL 60604 (800) 554-9862.

Hydrotopia (Mac), (6 - 12)
Ecology Center of Ann Arbor, 117 Division Street, Ann Arbor, MI 48104
(313) 995-5888.

Lake Study (Apple IIgs), (7 - 12)
Project Seraphim, Department of Chemistry, University of Wisconsin-
Madison, 1101 University Avenue, Madison, WI 53706 (608) 263-2837.

LaMotte Water Quality CD-ROM with *The Monitor's Handbook* (7 - 12)
LaMotte Company, 802 Washington Avenue, P.O. Box 329, Chestertown,
MD 21620 (410) 778-3100.

Learning About Water (Apple IIs or IBM) or (Laserdisc), (K - 6)
AIMS Media, 9710 DeSoto Avenue, Chatsworth, CA 91311-4409
(800) 367-2467.

NGS Kids Network: Acid Rain
(Apple II GS, Mac, or IBM + modem), (4 - 6)
National Geographic Society, Educational Services, P.O. Box 98017,
Washington, D.C. 20090-8017 (800) 368-2728.

NGS Kids Network: What's in Our Water? (Apple II GS, Mac, or IBM +
modem), (4 - 6)
National Geographic Society, Educational Services, P.O. Box 98017,
Washington, D.C. 20090-8017 (800) 368-2728.

Odell Lake (Apple IIe), (4-6)
MECC, 6160 Summit Drive North, Minneapolis, MN 55430-4003
(800) 685-MECC.

Operation Watershed CD (Windows or Mac), (4 - 12)
National 4-H Supply Service, c/o Crestar Bank, P.O. Box 79126, Baltimore,
MD 21279-0126 (301) 961-2934.

Our Environment, The Young Producers Series (Mac, Windows), (3 - 8)
Sunburst Educational Software, 101 Castleton, P.O. 100, Pleasantville, NY
10570 (800) 321-7511.

Physics Explorer: Ripple Tank (Mac, Windows), (9 - 12)
Sunburst Educational Software, 101 Castleton Street, P.O. Box 100, Pleasantville, NY 10570 (800) 321-7511.

Pond Study (Apple II, II Plus, IIe and Applesoft), (7 - 12)
Project Seraphim, Department of Chemistry, University of Wisconsin-Madison, 1101 University Avenue, Madison, WI 53706 (800) 991-5534.

Project Water Works (Apple II-e), (6 - 12)
American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235 (303) 794-7711.

SimCity 2000 (DOS, Mac, Windows 3, Windows 95), (9 - 12)
SimTown (CD-ROM), (9 - 12)
Maxis, 2121 North California Boulevard, Suite 600, Walnut Creek, CA 94596-9854 (800) 336-2947.

STV Water (Videodiscs), level I (4 - 9) and III (4 - 9)
National Geographic Society, Educational Services, P.O. Box 98017, Washington, D.C 20090-8017 (800) 368-2728.

The Digital Field Trip to the Wetlands (CD-ROM), (9 - 10)
Tangent, 261 Martindale Road, Unit 10, St. Catharines, Ontario, Canada L2W 1A2 (800) 363-2908.

The Earth's Water (MS-DOS 3.5", Apple, IBM 5.25" or Mac), (7 - 12)
Queue, Inc., 338 Commerce Drive, Fairfield, CT 06430 (800) 232-2224.

The Environment (Mac, Apple, MS-DOS; Spanish version in Mac), (5 - 12)
Tom Snyder Productions, 80 Coolidge Hill Road, Waterstown, MA 02172 (800) 342-0236.

The Great Ocean Rescue (CD-ROM), (5 - 8)
Tom Snyder Productions, 80 Coolidge Hill Road, Waterstown, MA 02172 (800) 342-0236.

The Water Cycle (Apple II's), (3 - 6)
Lawrence Productions, Inc., 1800 South 35th Street, Galesburg, MI 49053 (800) 421-4157.

WAQUAL (Apple IIgs, II Plus, IIe, and Applesoft), (7 - 12)
Project Seraphim, Department of Chemistry, University of Wisconsin-Madison, 1101 University Avenue, Madison, WI 53706 (800) 991-5534.

Waternet Database, (CD-ROM), (9 - 12)
American Water Works Association, Information Services Department, 6666 West Quincy Avenue, Denver, CO 80235 (303) 347-6170.

Note: Publishers of a majority of the 9 - 12 level software indicate the material is also appropriate for the college and adult level.

On-Line Addresses

The following on-line addresses pertain to water-related projects and information.

http://ice.ucdavis.edu/California_Watershed_Projects_Inventory/
California Watershed Projects Inventory

http://hermes.ecn.purdue.edu:8001/server/water/water.html
Cooperative Extension Service National Water Quality Database

http://wwwdwr.water.ca.gov/
DWR (Department of Water Resources) California Water Page

http://www.water.ca.gov.
DWR (Department of Water Resources) World Wide Web Gateway,
(includes California Irrigation Management Information System [CIMIS])

http://nceet.snre.umich.edu/index.html
EE Link, Environmental Education on the Internet

http://www/igc.apc.org/igc/www.water.html
EcoNet's Water, Seas, Oceans, and Rivers Directory

http://www.uex.edu/erc/ywc/./
Educating Young People about Water

http://www.igc.apc.org/green/green.html
Global Rivers Environmental Education Network

http://etd/pnl.gov:2080/hydroweb.html
Hydrology Web, Earth and Environmental Sciences Center

http://h2o.er.usgs.gov/
USGS Water Resources of the United States

http://www.water-ed.org
Water Education Foundation

http://resources.agency.ca.gov/ceres/WOL/home.html
Water On-Line, CERES (California Environmental Resources Evaluation System)

http://www.waterwiser.org.
WaterWiser, The Water Efficiency Clearinghouse
American Water Works Association

rwwet@msu.oscs.montana.edu
WETNET, Project WET (Water Education for Teachers) Network